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ABSTRACT

This handbook is intended to assist postsecondary Kentucky vocational education instructors in determining the mathematics competencies that they should address in their courses. The competency listings and resource information included in the handbook are based on information obtained from 109 postsecondary vocational instructors throughout the state. The first section describes the development of the handbook and the importance of math competencies throughout the continuum of technical and nontechnical vocational education programs. The second section includes listings of accepted competencies for the following program areas: air conditioning, auto body, auto mechanics, carpentry, drafting, electricity, electronics, graphic arts, machine shop, masonry, and welding. Section 3 provides additional competencies and comments obtained at several points throughout the project. The fourth section lists resources for teaching math (including texts, audiovisual materials, and computer software), and the fifth section discusses ways in which the information provided can be used to improve vocational programs. Appendixes include the 10 surveys used to develop the handbook, tabulations of the survey responses, lists of competencies that were not selected, examples of competencies, and evaluation forms. (MN)

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Math Exit Competencies

HANDBOOK

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Math Exit Competencies Handbook
for
Selected Kentucky postseconadry Industrial Education Programs: Air Conditioning, Autobody, Automechanics, Carpentry, Drafting, Electricity, Electronics, Graphic Arts, Machine Shop, Masonry, Welding.

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During the project to develop the handbook, 109 instructors provided information to develop competency listings and resource information. Many more instructors and resource teachers then helped to evaluate what was developed and add suggestions and comments. This handbook would not have been possible without the participation of these dedicated group of professionals. We thankyou for what you have helped us accomplish.

In the background were many vocational school principals, counselors, and resource teachers. They worked with us without compaints to help us complete project activities on time. We thank them for their patience and persistence in assisting us.

Our planning committee helped us get a good start the first year of the project. We deeply appreciate the committee's efforts.

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As project director, my sincere thanks goes to Susan Brown and Barbara Sworin. They assumed the responsiblities and added quality to the handbook. They share in the success of the project.

Foreword

This handbook is to be used to maintain and improve the quality of 11 vocational programs. Information for the handbook was obtained by asking instructors from every post-secondary vocational school in Kentucky to provide input.

The first section provided a background for understanding the handbook information. The "why" and "how" of what was done is explained. Some key definitions are discussed in this section.

The second section provides listings of accepted competencies for the eleven programs of: Air Conditioning, Auto Body, Auto Mechanics, Carpentry, Drafting, Electricity, Electronics, Graphic Arts, Machine Shop, Masonry, and Welding. This section should be of particular interest to instructors and resource teachers as they strive to determine what math should be offered in vocational programs.

The third section provides additional competencies and comments obtained at several points during the project. This information can be used to initiate discussions about additions and deletions that should be made to competency lists.

Section 4 lists resources for teaching math. This includes texts, audio-visual materials, and computer software that could be used for instruction.

The fifth section gives information about how all the information can be used to improve programs. This section should help handbook users to develop plans for improvement.

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Section 1

Background and Overview

High technology is bringing about numerous changes in the workplace. New goods and services are being introduced, established products are being phased out, and processes that have been the basis for production are changing. As a result, many new industries are emerging while others are either upgrading to meet the challenges or going out of business.

Changes in industry have a significant effect on employment. Between 1984 and 1995, the Bureau of Labor Statistics estimates that over 15 million new jobs will be available. Many of these jobs will have job descriptions that focus on high technology applications that use computers, electronics, automation, robots, and related systems. Other positions will require new skills and knowledge to meet job requirements.

Persons applying for these positions will be expected to have certain sets of competencies that enable them to work with new industrial innovations. This will require workers to have strong and diverse backgrounds in practices and principles of their occupational areas, as well as good math backgrounds that allow applications to a variety of technical problems.

Other factors affecting workers are job obsolescence and displacement. Workers can expect to change occupations and jobs a number of times during their careers. They must

be prepared to adapt quickly and effectively to new job requirements. As jobs become more technical, it is very important for workers to stay current in their occupations along with building expertise in skills that allow transfer to other related positions. The application of scientific principles through problem solving and math appears to be necessary to make transitions to the jobs of tomorrow.

Future employment is shifting to small businesses. This trend affects the educational preparation of prospective workers because small businesses cannot provide extensive training. Workers entering small businesses must have relevant and broad skills and knowledges that can be applied to job responsibilities. Future workers will have to be trained to deal with many practices and principles of their occupational areas and be able to make quick and efficient applications to new situations.

It is difficult to predict the exact skills and knowledges that are needed by prospective workers to succeed in the everchanging world of industry. However, some assumptions can be made. The move toward high technology requires workers to have more knowledge in principles and practices that make up occupational competence. This competence must be combined with the ability to problem solve, troubleshoot, adapt to new situations and modify what is known to apply to technical innovations. Workers must be thoroughly trained in their occupational specialties and be adept at math skills that allow flexibility and efficiency in

coping with new situations in the workplace.

Education

Education is closely linked to the community. As changes in job requirements make it necessary to have additional skills, the public gives more input to schools about what is needed in the curriculum. Both general and vocational education have reacted to the feedback by making many changes. This will continue in the future and will challenge educators to meet change with change in order to prepare people for efficient transitions from training to the world of work.

General education has made many significant changes to ensure students are literate in math. For instance, more math is required than in the past to graduate from high school, there are fewer electives that students can select, and more math options are available to meet the diverse needs of the student population. There also seems to be greater attention devoted to ensuring that students have appropriate skills before allowing them to progress to more advanced experiences or passing them to higher grade levels. At the conclusion of high school, students must now pass a competency test to demonstrate their abilities to use math learnings.

Post-secondary vocational education is emphasizing math as an important part of vocational training. All incoming students must demonstrate competency in tests on the basics, including math. There are support strategies for helping

students learn math in vocational courses and remedial programs are available to help those that are deficient in math. School personnel are involved in determining the math that students should have when enrolled and instructors are continuously striving to teach the math that is necessary for successful employment.

Math competencies

The Test of Adult Basic Education (T.A.B.E.) is used in all state vocational technical schools in Kentucky to measure the basic math competencies of entering adult students. The test results are expressed by grade levels, and students must attain at least a 10th grade level to meet graduation requirements. The T.A.B.E. measuring instrument was used in the project as a reference to define "basic" math competencies. The term was defined as - those competencies in math that are listed in the T.A.B.E.

Vocational education stresses applications of basic math to a variety of occupational situations. As students progress, advanced applications require more difficult equations and problem solving. Students learn to identify where, when, and how to apply math skills in order to succeed in occupations.

At some point in vocational training, math competencies become more advanced than basic competencies. Instructors teach the math as they would any other course content. In some cases, a separate math book is used as reference. At other times, the math competency is integrated with

occupational content and is learned through a variety of teaching techniques. The challenge for instructors is to determine the advanced math competencies and decide on the degree of emphasis in instruction.

The advanced math competencies which vocational instructors select for teaching are arrived at by analyzing what workers do on the job . Thus, they might be described as math competencies necessary to succeed on the job. For the purpose of this project, advanced math competencies will be called "exit" math competencies, that is, those competencies students should have upon graduation from a vocational program so they are prepared to enter jobs for which they were trained.

One of the problems in trying to identify math competencies in vocational programs is that math content and occupational content are often linked so it is difficult to separate one from another. For this handbook, attempts were made to make math competencies non-occupational and general. However, in some cases this was not possible and resulted in listings that are both occupational and non-occupational related.

A Continuum

If all vocational programs were placed on a continuum from technical to non-technical each vocational program would be located in a unique position on the continuum. A number of programs would tend to group around the technical end of the continuum and would require a large number of math

competencies, while a number of programs would be grouped near the non-technical end of the continuum and would require fewer math competencies. Other programs would fit somewhere in between.

During the first year of the project, the 4 programs of electronics, electricity, drafting, and machine shop were analyzed for math competencies. If placed on a continuum, these programs would seem to fit somewhere near the technical end of the continuum. Thus, it was expected that they would have a large number of competencies in comparison to other vocational programs and many of the exit math competencies should be "common" to the 4 selected programs.

For the second year of the project, the programs of air conditioning, auto body, auto mechanics, carpentry, graphic arts, masonry and welding were selected. These programs were probably less technically oriented than the programs selected for the first year. This factor might determine numbers of competencies specific to each program and common to a number of the 7 programs.

The Advisory Committee

An advisory committee was organized to assist with important decisions. The committee members were selected to be representative of groups that were very concerned with the teaching of exit math competencies. A meeting was held in the fall of 1987 to provide direction for the project. Information related to the advisory committee meeting can be examined in the final project report for 1987.

The Survey Instruments

A survey instrument for each of the 11 selected program was developed to give instructors a starting point for identifying exit math competencies. An information sheet was included with the survey instrument to determine resources used by instructors. See Appendix 1 for the information sheet and survey instruments.

The first step in developing the survey instruments was to seek information about exit math competencies. This started with a literature search and review of information from a computerized eric search and numerous materials provided by the Office of Vocational Education, Frankfort, Kentucky. There was a limited amount of information that related to exit math competencies. There was a significant amount of information about basic math competencies.

Because of the limited information, the decision was made to conduct an analysis to identify exit math competencies. A number of textbooks were selected as representative of the math content for the 11 programs (see Section 4 for a listing of textbooks). For each program, textbooks were analyzed and a list of math competencies was compiled. In some instances math competencies were easily identified and taken directly from the textbook; in other instances tasks were analyzed to determine what math skills were needed to successfully complete the tasks. The resulting 11 lists of math competencies were then sorted by whether they were basic or exit math competencies. The lists

of basic math competencies were discarded. Exit math competencies were ordered according to difficulty (simple to complex) and in certain instances were grouped by activities such as graphing. The resulting lists were used for developing the survey instruments.

Instructors Input

Instructors were selected to determine the math competencies that were needed and should be included in vocational programs. The reasoning for the decision was that instructors can be considered an extension of industry. They meet and communicate with industry on a continuing basis. They are also involved with staff-industry exchange experiences and many continue working in their occupational specialties during time off from teaching.

A beginning step was to determine which instructors from drafting, electricity, electronics, and machine shop would be asked to participate in the study. Some schools had day and evening courses and more than one teacher per course. There was the possibility that if survey instruments were sent to all instructors, duplicate responses would be received from schools that had a number of instructors. To be sure this did not happen, the decision was made to select one day instructor and one night instructor from each of the 14 post-secondary schools. A guidance counselor or related teacher in each of the schools provided names of instructors who should receive the survey instrument.

The survey instruments were mailed to the 61 selected instructors from the 4 programs. They were asked to examine the curriculum and teaching materials in order to respond to the instrument as accurately as possible. Also, instructors were asked to share the results with other co-workers so the decisions about competencies would be program oriented.

For the second year, the decision was made to include all instructors from the seven remaining programs in the sample to select competencies. This was done because there seemed to be 1 teacher per day and\or evening sessions. Duplication of responses from schools did not appear to be a problem. Ninety instructors were sent the information sheets and survey instruments.

The Results

The responses from the instructors was reviewed and analyzed. This resulted in discussions about competencies selected and not selected. Other supporting information was listed to provide a background that would assist instructors, curriculum developers and others to effectively utilize the information.

Field Review

After the first year of the project, the final report was shared with related teachers and instructors from the 4 program areas. They were asked to evaluated the information in the report and provide suggestions for correction. During the second year of the project, the competency lists for the 7 remaining programs were sent to all teachers from the

program areas. They were requested to evaluate the competencies selected by teachers from their program areas.

Section 2

Exit Math Competencies for Selected Vocational Programs

Instructors from 11 post-secondary vocational programs were asked to identify exit math competencies. The explanation to the instructors was:

> The purpose of the project is to identify the math competencies needed upon graduation from a post-secondary program to gain meaningful employment in the occupation for which trained. The project is designed to determine the technical math competencies needed in (program name) above and beyond the math competencies identified on the T.A.B.E. test.

The assumption was made that students met entry level requirements for the selected program, therefore only new competencies to be acquired during instruction were listed. These competencies represented the math skills necessary to perform entry level job related tasks upon graduation from the selected program.

The decision about how the math competencies would be selected was:

> A competency was selected as needed for a vocational training program if the competency was indicated as necessary by at least 75% of the instructors responding to the survey instrument.

Each competency in the survey instruments was assigned a number and all of the information about specific competencies in the handbook was referenced to these numbers. Thus, it is

possible to identify a competency by number for a specific program (see the surveys in Appendix 1) and determine the status of the competency from tables and/or appendices. It should be noted that the first 77 competencies listed in the survey instruments were the same for the program areas of drafting, electricity, electronics, and machine shop. This occurred because of the technical similarities of the programs. In the other seven programs the competencies were generally different from program to program. Also, the same survey instrument was used for both electricity and electronics since many of the competencies for the programs were the same.

Table 1 lists the number of instructors that were selected for providing information. Ninety three percent or 14 of 15 electronics instructors returned the survey instrument. Only 8 of 18 welding instructors (44%) returned information and 1 of 3 masonry instructors completed and returned the survey instrument. Of the total participants, 73% or 109 of 150 instructors completed the survey instrument.

Table 1

Numbers of Instructors Participating in the Study

Program	Number of Instructors	Number Responding	Percentage Responding
Air Conditioning	14	12	86%
Auto Body	13	11	85%
Auto Mechanics	21	13	62%
Carpentry	14	11	79%
Drafting	17	12	71%
Electricity	14	12	86%
Electronics	15	14	93%
Graphic Arts	6	4	67%
Machine Shop	15	11	73%
Masonry	3	1	33%
Welding	18	8	44%
Total	150	109	73%

A tabulation of instructors' responses to the survey instruments for the eleven programs can be found in Appendix 2. These tables give the competency numbers and the number of instructors that indicated the competency was needed and not needed. Information from the tables was used with the 75% rule to determine whether competencies were selected or not selected.

When developing the survey instruments, textbooks and other reference materials were used to decide the lists of math competencies. These competencies were considered a starting point for instructors to select needed competencies for the training programs. Table 2 provides information about the acceptance of these competencies by instructors when the 75% rule was used. The electronic instructors selected 96 of 119 or 84% of the competencies as necessary. Electricity and air conditioning instructors were less receptive to the listings. Only 23% of the competencies were accepted by the air conditioning instructors and electricity instructors rejected 82% of the competencies. It appeared that the texts and other information used to develop survey instruments in the two areas did not reflect what the instructors thought should be taught. In other areas acceptance ranged from 45% (machine shop) to 78% (masonry).

Table 2

Acceptance of Competencies by Instructors

Program	Number Selected	Percentage Selected	Number Not Selected
Air Conditioning	18	23%	59
Auto Body	16	50%	16
Auto Mechanics	29	67%	14
Carpentry	41	69%	18
Drafting	94	57%	71
Electricity	25	18%	117
Electronics	119	84%	23
Graphic Arts	21	68%	10
Machine Shop	54	45%	66
Masonry	35	78%	10
Welding	26	70%	11

The 75% rule was an arbitrary decision to be able to separate competencies that instructors believed were necessary and not necessary. Using another rule would have led to different results. Table 3 gives the numbers of competencies selected by instructors. For air conditioning, 0% to 35% of the instructors selected 34 of the competencies in the survey instrument. This is in contrast to the 18 competencies that were selected by 75% or more of the air conditioning instructors. Electricity instructors were

another group that did not seem to agree on the competencies in the survey. Zero percent to 35% of the instructors selected 65 competencies. Only 25 of 142 competencies were selected by 75% or more of the instructors. The numbers of competencies selected by drafting instructors were also spred out among groups of instructors. However, 75% or more of the drafting instructors did agree on the selection of 94 competencies.

As discussed previously, a number of competencies in each of the survey instruments were rejected by instructors. These can be found in Appendix 3.

Table 3

Numbers of Competencies Selected by Instructors

Program	Number of Competencies Selected					
	Percentage of Instructors Selecting					
	0-35%	36-45%	46-55%	56-65%	66-74%	>75%
Air Conditioning	34	13	6	5	1	18
Auto Body	0	0	9	3	4	16
Auto Mechanics	0	0	12	2	0	29
Carpentry	12	1	4	1	0	41
Drafting	17	7	13	19	15	94
Electricity	65	15	12	13	12	25
Electronics	0	1	0	1	3	119
Graphic Arts	7	0	3	0	0	21
Machine Shop	29	11	15	9	2	54
Masonry	10	0	0	0	0	35
Welding	7	0	1	3	0	26

Common competencies

As the completed survey instruments were analyzed, it was apparent that a number of competencies were common to electricity, electronics, drafting and machine shop programs. Table 4 lists these competencies. They are non-occupationally specific, that is the competencies were stated

without reference to occupations. This does not mean they are used in this form in any of the programs. In a training situation, the competencies may be used as stated, combined with occupational information and/or used with several other competencies to arrive at appropriate solutions to problems. The survey instruments for air conditioning, auto body, auto mechanics, carpentry, graphic arts, masonry, and welding did not have competencies in common.

Table 4

Common Exit Math Competencies for the Vocational Programs of Drafting, Electricity, Electronics, Machine Shop

---

1. Add, subtract, multiply, and divide on a number line.
9. Square a number.
10. Square a monomial.
26. Solve equations with one unknown. 45. Determine
45. Determine complimentary and supplementary angles of a triangle.
46. Find the arc, sine, cosine, and tangent of an angle.
47. Find functions of angles for angles greater than 90.
49. Solve a problem involving similar right triangles.
51. Solve for angle, lines, and hypotenuse for a right triangle.
53. Solve word problems related to a right triangle.
58. Convert a fraction to a decimal.

It can be difficult to understand what type of problem might be associated with a particular competency. Appendix 4 gives examples of accepted competencies for drafting, electricity, electronics, and machine shop. These can be reviewed for each of the competencies in the four programs to arrive a clearer understanding of how a competency may be used.

Competencies specific to programs

Table 5 displays the competencies selected by 12 drafting instructors. The common competencies in Table 4 should be added to these competencies to arrive at a complete list. The competencies in this table are a mix of occupationally specific and non-specific competencies. There are also a number of competencies that relate to conversion between the English and metric system of measurement.

Table 5

Math Competencies for Drafting (N = 12)

---

2. Represent the products of two numbers on a graph.

3. Find the value of a radius vector graphically.

5. Determine x and y intercepts on a graph.

7. Convert a whole number to a positive power of ten.

17. Multiply and divide numbers with exponents.

24. Group terms in an equation.

27. Solve equations by transposing.

28. Solve an equation by canceling a term.

29. Check solutions for equations.

30. Form equations from observed data.

31. Solve a problem using a formula with knowns and one unknown expressed in the same unit.

32. Solve a problem involving 2 formulas, 3 or more knowns, and one unknown.

48. Find functions of an angle in second, third, and fourth quadrants.

50. Find trigonometric ratios of angles of right triangles.

55. Reduce a fraction to its lowest term.

57. Add, subtract, multiply and divide fractions.

77. Find the correct proportions of selected objects.

78. Determine dimensions to scale.

Define the following :

79. Parts of a circle.

80. Concentric circles.

81. Eccentric circles.

82. Right angle.

83. Acute angle.

84. Obtuse angle.

85. Complementary angle.

86. Supplementary angles.

87. Calculate the area and circumference of a circle.

List the side and or angle relationships for the following:

88. Equilateral triangle.

89. Isosceles triangle.

90. Scalene triangle.

91. Right triangle.

92. Right triangle in a semi-circle.

93. Square.

94. Rectangle.

95. Rhombus.

96. Rhomboid.

97. Trapezoid.

98. Trapezium.

99. Pentagon.

100. Hexagon.

101. Heptagon.

102. Octagon.

111. Right square.

112. Oblique triangle.

127. Divide lines into equal divisions.

128. Determine the measurements of enlarged and reduced objects.

129. Determine the tolerances and limits of drill holes.

130. Determine clearance, transition, and interference fits.

131. Determine dimensions and tolerances of an internal and an external cylindrical surface.

132. Compute horizontal and vertical spacing of an object.

133. Construct a bar graph.

134. Describe information from a line graph.

135. Construct a circle graph and pie chart.

136. Compute diametral pitch of a thread.

137. Compute circular pitch of a thread.

138. Compute vertical spacing, given the working space and height of an object.

139. Compute diametral pitch of a gear.

140. Compute circular pitch diameter of a gear.

141. Compute pitch diameter of a gear.

142. Compute outside diameter of a gear.

143. Compute root diameter of a gear.

144. Compute addendum of a gear.

145. Compute dedendum of a gear.

146. Calculate whole depth using a formula.

147. Compute circular thickness of a gear.

148. Determine metric numbers that represent the SI prefix symbols.

149. Determine metric prefix names for prefix symbols.

150. Find the equivalent value in metrics of a value with a prefix symbol.

151. Determine customary lengths for selected metric lengths.

152. Convert units in the metric system.

153. Convert lengths from English to metric.

154. Calculate areas of objects in the metric system.

155. Convert lengths from metric to English.

156. Convert dimensions of objects from English to metric.

157. Convert areas measurements to metric areas.

158. Compute metric volumes.

159. Convert customary dimensions to metric dimensions and calculate the volume in metric units.

Find the correct drafting scale ratio in metrics for:

160. Assembly drawings.

161. Detail drawings.

162. Working drawings.

163. Site plans.

164. Surveys.

165. Maps.

Twelve electricity teachers responded to the survey instrument. There was not agreement that the competencies in the survey were necessary for an electricity program. Fourteen competencies plus the common competencies were selected. A number of the selected competencies, as shown in Table 6, were related to solving equations. Others were occupationally specific dealing with vectors in AC circuits.

Table 6

Math Competencies for Electricity (N = 12)

7.	Convert a whole number to a positive power of ten.
13.	Take the square root of a monomial.
27.	Solve equations by transposing.
29.	Check solutions for equations.
30.	Form equations from observed data.
31.	Solve a problem with a formula, knowns and one unknown
37.	Factor a simple equation.
59.	Set up equations from theory.
91.	Find the magnitude and direction of vectors.
92.	Find the horizontal and vertical components of vectors.
93.	Find the resultant forces of vectors.
97.	Write equations for voltage and current using an AC circuit.
98.	Draw vector diagrams for AC circuits.
110.	Express numbers in the binary number system.

Table 7 lists the competencies selected by 13 electronics instructors. There are more competencies for electronics than for other occupational training programs.

Table 7

Math Competencies for Electronics (N = 13)

---

2. Represent the products of two numbers on a graph.
3. Find the value of a radius vector graphically.
4. Represent trigonometric functions by graphing.
5. Determine x and y intercepts on a graph.
6. Solve two simultaneous equations by graphing.
7. Convert a whole number to a positive power of ten.
8. Add, subtract, multiply and divide positive and negative powers of ten.
13. Take the square root of a monomial.
15. Square a binomial.
17. Multiply and divide numbers with exponents.
18. Multiply a number with an exponent by an exponent.
19. Multiply a fraction with an exponent by an exponent.
20. Express numbers with negative exponents as numbers with positive exponents.
21. Find the values of numbers with fractional exponents.
25. Determine signs in a complex equation.
27. Solve equations by transposing.
28. Solve an equation by canceling a term.
29. Check solutions for equations.

30. Form equations from observed data.

31. Solve a problem using a formula with knowns and one unknown expressed in the same unit.

32. Solve a problem involving 2 formulas, 3 or more knowns, and one unknown.

33. Solve a problem involving 3 formulas, 3 or more knowns, and one or more unknown.

34. Solve a quadratic equation.

35. Solve equations with the quadratic formula.

37. Factor a simple equation.

38. Find the prime factors of equations.

39. Find the product with the difference and sum of two equations.

41. Solve simultaneous linear equations by addition and subtraction.

42. Solve simultaneous linear equations by addition and subtraction.

43. Solve simultaneous equations by comparison.

44. Solve fractional form simultaneous equations.

48. Find functions of an angle in second, third and fourth quadrants.

50. Find trigonometric ratios of angles of right triangles.

52. Solve graphically for elements of a right triangle.

59. Set up equations from theory.

60. Express equations in logarithmic form.

61. Find the logarithm of a product.

62. Find the logarithm of a quotient.

63. Find the logarithm of a power.
64. Find the logarithm of a root.
65. Find the logarithm of a number.
66. Express equations in exponential form.
67. Find the antilog of a number.
68. Add logarithms.
69. Subtract logarithms.
73. Multiplication and division by logarithms.
78. Solve electronic problems using logarithms.
79. Express gain or loss of apparatus in decibels.
80. Express gain or loss of quantities in decibels.
84. Graph the equation.
85. Graph the cosine curve.
86. In equations of periodic curves, specify frequency.
87. In equations of periodic curves, specify angle of velocity.
88. In equations of periodic curve, specify the amplitude.
89. In equations of periodic curve, specify period.
90. In equations of periodic curve, specify angle of lead or lag.
91. Find the magnitude and direction of vectors.
92. Find the horizontal and vertical components of vectors.
93. Find the resultant forces of vectors.
94. Use vector diagrams to find instantaneous values in an AC circuit.
95. Determine angles in a vector diagram of an AC circuit.
96. Find the angular velocity of an AC circuit.

97. Write equations for voltage and current using an AC circuit.
98. Draw vector diagrams of circuits and construct vectors for AC circuits.
99. Determine angles in a vector diagram and plot imaginary numbers on a vector diagram.
100. Express AC circuit parameters in polar form.
101. Convert AC circuit parameters from rectangular to polar form and vice versa.
102. Solve problems using parameters expressed in rectangular form.
103. Solve problems using parameters in polar form.
104. Add vectors in rectangular form.
105. Subtract vectors in rectangular form.
106. Multiply vectors in rectangular form.
107. Divide vectors in rectangular form.
108. Multiply polar vectors.
109. Divide polar vectors.
110. Express numbers in the binary number system.
111. Construct and analyze truth tables.
112. Develop a Boolean equation from a logic diagram.
113. Use the sum of products method to solve a Boolean equation.
114. Develop a sum-of-products equation from a truth table.
115. Simplify a Boolean equation.
116. Convert a truth table into a Karnough map.
117. Draw a three and four variable Karnough map from

a truth table.

118. Simplify a Karnough map using octets, quads, or pairs.

119. Use the product of sums to simplify a truth table.

120. Convert a truth table to an equation.

121. Simplify a product of sums equation.

122. Use multiplexer logic.

123. Find BCD equivalents of decimal numbers.

124. Convert binary numbers to decimal equivalents.

125. Convert octal numbers to decimal equivalents.

126. Find the decimal equivalents of an octal number.

127. Convert hexadecimal numbers to binary numbers.

128. Express a decimal number in excess - 3 code.

129. Express an excess - 3 number as a decimal number.

130. Convert gray numbers to a decimal equivalent.

131. Give the sum of numbers in base 8 or 16.

132. Sum of binary numbers.

133. Add whole numbers in base 10 using 16 bit numbers.

134. Subtract binary numbers.

135. Subtract whole numbers in the base ten system.

136. Determine overflow of problems with 8 bit unsigned arithmetic.

137. Express positive or negative whole numbers in 8 bit sign magnitude form.

138. Convert sign magnitude number into decimal equivalent.

139. Express the complement of numbers in hexadecimal notation.

140. Express the 2's complement of binary numbers.

141. Convert positive or negative whole numbers to 2's complement representation.

142. Show the 8 bit addition and subtraction of decimal numbers in 2's complement representation.

Eleven machine shop instructors responded to the survey. The competencies they selected are listed in Table 8.

Table 8

Math Competencies for Machine Shop (N =11)

---

50. Find trigonometric ratios of angles of right triangles.

78. Convert from English units to metric units and visa versa.

79. Determine tolerance for a measurement.

80. Find the circumference for a circle.

81. Find the perimeter of any polygon.

82. Find the area of a circle.

83. Find the pitch of a screw.

84. Find the cutting speed, given the revolutions of lathe per minute, and the diameter.

85. Solve problems using percentages.

86. Read a micrometer.

87. Read a vernier caliper.

88. Read a vernier protractor.

89. Subtract with degrees, minutes, and seconds.

90. Find decimal equivalents of minutes and seconds.

91. Find minute and second equivalents of decimals.

92. Determine sizes of angles on drawings.
93. Find the area of a circle, triangle, square, parallelogram and rectangle.
94. Find the diagonal of a square.
95. Find the distance across the flats or corners in a hexagon.
96. Use a table of natural functions to find a function of of an angle.
97. Interpolate to find values of angle functions for minutes.
98. Use the Law of Sines to solve an oblique triangle.
99. Use the Law of Cosines to solve an oblique triangle.
100. Determine the amount of taper.
101. Determine the amount of offset needed to produce a given taper.
102. Convert taper measurements to angle measurements.
103. Determine the amount of error in a given taper.
104. Use a general speed formula for two gears in mesh to solve problems.
105. Solve problems involving simple and compound gear trains.
106. Solve problems involving worm gearing.
107. Find the rpm of a tool, knowing the cutting speed and diameter.
108. Calculate drill speeds.
109. Find the rate of feed for lathe tools.
110. Determine a cutting time for lathe and milling

operations

111. Find the pitch of a thread.

112. Measure a screw thread.

113. Determine outside diameters and tap drill sizes for machine screws.

114. Find the outside diameter of a gear, knowing the number of teeth and diametrical pitch.

115. Find the center to center distance for two meshing spur

117. Use continued fractions to convert speed ratio's into gear combinations.

118. Convert metric module to diametrical pitch.

119. Determine the number of turns on a dividing head for indexing.

120. Index for degrees, minutes, and seconds.

Tables 9 through 15 display the competencies for air conditioning, auto body, auto mechanics, carpentry, graphic arts, masonry, and welding.

Table 9

Math Competencies for Air Conditioning (N = 12)

---

1. Add, subtract, multiply and divide on a number line.
29. Solve a problem using a formula with knowns and one unknown expressed in the same unit.
43. Determine dimensions of a drawing to scale.
44. Calculate the area and circumference of a circle.
55. Write equations for voltage and current using a circuit.
57. Find the circumference for a circle.
59. Find the area of a circle.
61. Determine the sizes of angles on drawings.
64. Change centigrade to Farenheit.
65. Change Farenheit to centigrade.
67. Convert prefixes with units to numbers with units.
68. Convert prefixes with units to powers of ten with units.
70. Solve problems with different units.
72. Interpolate readings on meter scales.
73. Determine the distance relationship of parts from a drawing.
75. Measure diameters to close tolerances.
76. Measure clearances to close tolerances.
77. Calculate percentages of quantities.

Table 10

Math Competencies for Auto Body (N = 11)

1.	Add and subtract in inches.
12.	Add and subtract using fractions.
14.	Calculate the tolerance for underbody alignment.
15.	Calculate the usual clearance between the door and the surrounding frame.
16.	Calculate the correct air pressure for spraying paint.
17.	Calculate the amount of fiberglass and resin needed to form an auto body.
20.	Determine tolerance for a measurement.
21.	Solve problems using percentages.
22.	Determine the sizes of angles on drawings.
24.	Calculate the five angles for steering alignment.
25.	Calculate the tolerance for mash in a car frame.
26.	Measure the steering axis inclination in degrees.
27.	Measure the tire-wearing angle in degrees.
28.	Determine the tolerances for frame adjustment.
29.	Measure frames and car bodies using tram guages.
32.	Calculate an estimate of the cost of repair work for a job.

Table 11

Math Competencies for Auto Mechanics (N = 13)

---

1. Add, subtract, multiply, and divide fractions.
2. Add and subtract in inches.
3. Convert lengths from English to metric.
4. Convert dimensions of objects from English to metric.
5. Convert area measurements to metric areas.
6. Convert fractions to decimals.
7. Convert decimals to fractions.
8. Find the diameter of a circle.
9. Find the radius of a circle.
10. Determine tolerance for a measurement.
11. Calculate the tolerance for underbody alignment.
12. Solve problems using percentages.
14. Calculate the five angles for steering alignment.
16. Measure the steering axis inclination in degrees.
17. Measure the tire-wearing angle in degrees.
18. Calculate an estimate of the cost of repair work for a job.
19. Read a conventional micrometer.
20. Read a metric micrometer.
21. Read a dial indicator.
22. Convert temperature readings from Farenheit to Celsius.
23. Use Ohm's law to determine the amount of resistance in a circuit.
24. Determine an engine's piston displacement.

25. Determine engine displacement or size.

28. Determine the engine compression ratio.

29. Determine the compression pressure of an engine cylinder.

39. Read a dwell meter.

40. Read a tachometer.

42. Read a vacuum guage.

43. Read an engine analyzer.

Table 12

Math Competencies for Carpentry (N = 11)

---

1. Square a number.
2. Determine complementary and supplementary angles of a triangle.
3. Solve a problem involving similar right triangles.
4. Solve word problems related to a right triangle.
5. Convert a fraction to a decimal.
6. Compute horizontal and vertical spacing of an object.

Find the correct drafting scale ratio for:

18. Site plans.
19. Plot plans.
20. Elevation plans.
21. Construction plans.

22. Find the perimeter of any polygon.
23. Solve problems using percentages.
27. Determine sizes of angles on drawings.
28. Find the area of a triangle, square, parallelogram, and a rectangle.
29. Find the diagonal of a square.
31. Find the board footage needed for construction.
32. Estimate the number and size of floor joists.
33. Use an archetect's scale to check the dimensions on a scaled drawing.
34. Use a folding rule to scale a plan.
35. Figure the normal dead load.

36. Figure the live load.
37. Estimate the number of studs needed for a wall or partition.
38. Estimate the amount of wall sheathing needed for the structure.
39. Use a framing square to estimate the approximate length of rafters.
40. Calculate the length of a common rafter using the table on the framing square.
41. Calculate the common difference of jack rafters with the third and fourth line of the rafter table.
42. Calculate the number of rafters required for a gable roof.
43. Estimate the amount of roofing materials needed using a carpenter's rule.
44. Find the tolerance for window clearance.
45. Estimate the amount of siding needed for a structure.
47. Determine the amount of insulation needed for a structure.
48. Estimate the board feet of strip flooring needed to cover a given area.
49. Calculate the number and size of risers and treads for a given stair run.
52. Determine sizes of saw blades in points per inch.
53. Determine the sizes of drill bits in inches.
54. Check building lines from a scaled drawing.
55. Find differences in grade level at several points.

56. Determine floor levels, grade lines, window and door heights, roof slopes from elevation views.
57. Calculate concrete amounts by the cubic yard.
58. Find the number of blocks for a foundation wall.
59. Find a roof area.

Table 13

Math Competencies for Graphic Arts (N = 4)

---

2. Convert from inches, points, picas to picas, inches, points.
3. Interpolate measurements in inches, points, and picas.
12. Convert fractions to decimals.
13. Convert decimals to fractions.
14. Measure accurately from the layout the position of words or lines.
15. Determine top and side margins of pages using percentages.
16. Solve problems to determine size of vertical margins of paper.
17. Find the average length of a line of print in page.
18. Find the number of characters that will fit into a selected line length.
19. Find the column depth by the point size.
20. Determine percent reductions of original copies.
21. Read and interpolate numbers from a proportional scale.
22. Determine enlargement size and reduced size of photographs.
23. Give enlargement and reduction specifications of photos in percentages.
24. Determine the relationship between percentage of copy reduction and number of points in the printed product.
25. Read and interpolate values on a "Density of Copy"

scale.

26. Determine appropriate screen angles when printing Duotone prints.

28. When cutting paper, calculate the number of press sheets that can be obtained from the stock sheet.

29. When cutting paper, figure the number of stock sheets needed.

30. Find the 1,000 sheet weights of special size sheets.

31. Find the cost of paper in different quantities.

Table 14

Math Competencies for Masonry (N = 1)

---

1. Add, subtract, multiply and divide whole numbers.
2. Add, subtract, multiply and divide decimals.
3. Convert a fraction to a decimal.
4. Convert decimals to fractions.
5. Add, subtract, multiply and divide fractions.
16. Compute metric volumes.
17. Determine complementary and supplementary angles of a triangle.
18. Solve a problem involving similar right triangles.
19. Solve word problems related to a right triangle.
20. Use percentages to solve problems.
21. Calculate the amount of interest paid on a loan.
22. Determine the length of a line.
23. Calculate the circumference of a circle.
24. Calculate the area of a parallelogram, trapezoid, triangle, regular polygon, circle, and ellipse.
25. Calculate the volume of a rectangular solid, prism, cylinder, cone, pyramid, and sphere.
26. Estimate the amount of brick masonry needed for a wall unit.
27. Estimate the amount of damp sand needed for mortar.
28. Determine the sizes of angles on drawings.
29. Find the diagonal of a square.
30. Use an archetect's scale to check the dimensions on a

scaled drawing.

31. Figure the normal dead load.
32. Figure the live load.
33. Find the tolerance for window clearance.
34. Determine the amount of heat lost through certain materials.
35. Calculate the number and size of risers and treads for a given stair run.
36. Calculate the area of a flue.
37. Check building lines from a scaled drawing.
38. Find the differences in grade level between several points.
39. Determine floor levels, grade lines, window and door heights, roof slopes from elevation views.
40. Calculate concrete amounts by the cubic yard.
41. Find the number of blocks for a foundation wall of a certain perimeter.
42. Determine the number of ties needed per square foot of wall.
43. Calculate the diameter and radius of a circle.
44. Calculate the width of footing for an 8" concrete block foundation wall in inches.
45. Calculate the proper slope for a walk or patio.

Table 15

Math Competencies for Welding (N = 8)

---

5. Convert lengths from Enlish to metric.
6. Convert area measurements to metric areas.
8. Find the area (in square inches) of a rectangle.
9. Convert fractions to decimals.
10. Convert decimals to fractions.
11. Add and subtract using fractions.
12. Find the diameter of a circle.
13. Find the radius of a circle.
14. Solve problems using percentages.
15. Determine the sizes of angles on drawings.
16. Find the diagonal of a square.
17. Find the area of a circle, rectangle, square, and triangle.
19. Determine the size of a groove weld.
20. Determine the pitch dimension of a weld.
21. Determine the groove angle for a weld.
22. Determine the effective throat size of a weld.
23. Determine the size of a fillet weld.
24. Determine the length dimension of a weld.
25. Determine the length, width, and angle of countersink for a slot weld from the assembly drawing.
26. Determine the maximum working guage pressure for acetylene gas.
27. Calculate the bevel angle on a weld.

28. Calculate the root opening for a weld.
29. Determine the clearance between two metals to be soldered.
33. Determine the argon flow rate in ft/ hr and L/min for welding various materials and joints.
34. Calculate the percent heat setting to the current range.
35. Calculate the duty cycle of resistance welding transformers.

Section 3

Competency Additions and Deletions

There were several opportunities during the project when instructors could select, add, or make comments about competencies needed for their programs. This section will list various instructors' input beyond what is listed in Section 2 so the information may be used with other competency related listings in the handbook.

The Survey

At the end of the survey there was an opportunity to list competencies that instructors believed should be added to the competency list. Twenty-seven of 109 instructors listed competencies (see Table 16). No more than two instructors listed any given competency and most competencies were listed by one instructor. Since a limited number of instructors presented competencies, no additions were made to listings for the field review.

Table 16

Additional Competencies Listed in the Surveys (N = 27)

Program	Competencies
Air Conditioning (N = 1)	1. Convert Celsius temperatures to Fahrenheit temperatures. 2. Convert Fahrenheit temperatures to Celsius temperatures. 3. Calculate and determine ratios for mixing paints and materials. 4. Determine the percentage of commission earned on a particular job. 5. Determine the discount when estimating damages to vehicles. 6. Determine what volume of paint is needed to cover a particular area. 7. Determine the percentage when dealing with reduction ratios for spray painting. 8. Determine the applied force pressure to release impact

	pressure.
	9. Determine the amount of thinner needed to reduce a specific volume of paint.
	10. Calculate the amount of fiberglass and resin needed to repair an auto body.
Auto Mechanics (N = 6)	1. Calculate speed in miles per second.
	2. Read graphs and charts.
	3. Convert the engine speed to road speed.
	4. Determine tire size.
	5. Read wiring diagrams.
	6. Read technical drawings.
	7. Follow flow charts.
	8. Determine ratios and proportions.
	9. Use calculators.
Carpentry (N = 3)	1. Calculate the area of a circle.
	2. Calculate the volume of rectangular and cylindrical shapes.
	3. Convert linear units in the English system.
	4. Convert area units in the

English system.

5. Use the pythagorean theorem to compute ratter length, stringer length, and the length of diagonals.
6. Convert decimal feet to feet and inches.

Drafting (N = 2)

1. Calculator algebra.
2. Calculator trigonometry and scientific notation.
3. Reading a micrometer.
4. Computer aided drafting.
5. Use architects', metric, civil, and mechanical engineer's scales.
6. Use precision measuring instruments.
7. Calculate force.
8. Construct hyperbolas and parabolas.
9. Construct the foci lines.
10. Construct the parallelogram ellipse.
11. Construct the helix.
12. Compute surface or rim speed.
13. Compute the area of a sector.

	14. Bisect or find the middle point of a line.
	15. Bisect an angle.
	16. Bisect an arc.
	17. Erect a perpendicular.
	18. Geometrically construct parallel lines.
	19. Calculate vector algebra.
Electricity (N = 3)	1. Calculator --algebra
	2. Calculator--trigonometry and scientific notation
	3. Graphing electrical quantities.
Electronics (N = 2)	1. Determinants.
Graphic Arts (N = 1)	1. Convert from English measure to pica.
	2. Add, subtract, multiply and divide numbers.
Machine Shop (N = 4)	1. Sketching and dimensioning.
	2. Dimensioning cylindrical work and tolerances.
	3. Dimensioning sections.
	4. Dimensioning threads.
	5. Measuring with micrometer caliper.
	6. Measuring with metric tools.

	7. Measuring with the divides and hermaphrodite calipers.
Masonry (N = 1)	1. Estimate all types of materials (brick, block, sand, mortar).
Welding (N = 4)	1. Convert PSI to load tons.
	2. Find the circumference of a circle.
	3. Calculate the capacities of rectangular, cylindrical, and square tanks.
	4. Determine lengths from scale.
	5. Calculate stretchouts for square, rectangular, circular, and semi-circular shapes.
	6. Determine the volumes of cubes, rectangular solids, and rectangular containers.
	7. Determine the volumes of cylindrical and complex containers.
	8. Determine the economical layouts of rectangular and odd shaped plates.
	9. Calculate the mass and weight of objects.

A final report was completed at the end of the first year. This report was given to sixteen related teachers and 51 instructors from the four program areas. They were asked to evaluate the general information in the report along with focusing on the validity of information specific to one or more of the four programs (See Appendix 5 for the evaluation form). Forty-four percent of the related teachers responded to the request and 16 of 51, or 31% of the instructors returned the requested information.

There were a few comments from the related teachers and instructors about how competencies were expressed and a number of errors were identified. This resulted in revisions to the information listed in this handbook.

The related teachers usually selected the competencies from one program to evaluate. Several of the teachers evaluated several areas. Suggestions from the related teachers and instructors about competencies that should be added are listed in Table 17. These suggestions did not result in changes to the competency lists, since not more than one of the evaluators usually made the same suggestion.

Table 17

Added Competencies from Field Review (N = 12)

Program	Competencies
Drafting (N = 4)	1. Calculate percentages.
	2. Use calculators.
	3. Be familiar with metrics
	4. Percentage calculations.
	5. Scientific calculator usage.
	6. Perform precision measurements with calipers, micrometers, and gage blocks.
Electricity (N = 3)	1. Determine metric numbers that represent the SI prefix symbols.
	2. Determine metric prefix names for prefix symbols.
	3. Find the equivalent value in metrics of a value with a prefix symbol.
	4. Determine customary lengths for selected metric lengths.
	5. Convert units in the metric system.
	6. Convert lengths from English

to metric.

7. Calculate areas of objects in the metric system.
8. Convert lengths from metric to English.
9. Convert area measurements to metric areas.
10. Compute metric volumes.
11. Convert English dimensions to metric dimensions and calculate the volume in metric units.
12. Determine angles in a vector diagram of an AC circuit.
13. Determine x and y intercepts on a graph.

Electronics

(N = 1)

1. Use trigonometric functions of sine, cosine, and tangent:
2. Calculate any side of a right triangle, with one side and one angle given.
3. Find either of the two angles that are less than 90 degrees, of a right triangle, with two sides given.
4. Use the pythagorean theorem to find a side of a right

triangle when two sides are given.

Machine Shop

(N = 4)

1. Determine x and y intercepts on a graph.
2. Group terms in an equation.
3. Solve equations by transposing.
4. Form equations from observed data.
5. Solve a problem using a formula with knowns and one unknown expressed in the same unit.
6. Factor a simple equation.
7. Find the least common multiple.
8. Reduce a fraction to its lowest terms.
9. Change sign of fractions.
10. Add, subtract, multiply and divide fractional equations.

Using trigonometric functions of sine, cosine, and tangent:

11. Calculate any side of a right triangle with one side and one angle given.
12. Find either of the two angles

that are less than 90 degrees, of a right triangle, with two sides given.

13. Determine x and y intercepts on a number line.
14. Group common terms in an equation.
15. Solve equations by transposing.
16. Solve an equation by cancelling a term.
17. Check solutions to equations.
18. Form equations from observed data.
19. Solve a problem using a formula with knowns and one unknown expressed in the same unit.
20. Factor a simple equation.
21. Find the least common multiple.
22. Reduce a fraction to its lowest term.
23. Change sign of fractions.
24. Add, subtract, multiply and divide fractions.

The instructors from the four program areas made comments about competencies that should be deleted. Table 18 provides these comments.

Table 18

Competencies Suggested for Deletion (N = 3)

Program	Competency
Drafting (N = 1)	77. Find the correct proportions of selected objects.
Electricity (N = 1)	13. Take the square root of a monomial.
	97. Write equations for voltage and current for an AC circuit.
	110. Express numbers in the binary number system.
Electronics (N = 1)	60. Express equations in logarithmic form.
	61. Find the logarithm of a product.
	62. Find the logarithm of a quotient.
	63. Find the logarithm of a power.
	64. Find the logarithm of a root.
	65. Find the logarithm of a number.

66. Express equations in exponential form.
67. Find the antilog of a number.
68. Add logarithms.
69. Subtract logarithms.
70. Multiply logarithms.
72. Division by logarithms.
73. Multiplication and division of logarithms.
96. Find the angular velocity of an AC circuit.
97. Write equations for voltage and current using an AC circuit.
98. Draw vector diagrams of circuits and construct vectors for AC circuits.
99. Determine angles in a vector and plot imaginary numbers on a vector diagram.
100. Express AC circuit parameters in polar form.
101. Convert AC circuit parameters from rectangular to polar form and visa versa.
102. Solve problems using parameters expressed in

rectangular form.

103. Solve problems using parameters expressed in polar form.

104. Add vectors in rectangular form.

105. Subtract vectors in rectangular form.

106. Multiply vectors in rectangular form.

107. Divide vectors in rectangular form.

108. Multiply polar vectors.

109. Divide polar vectors.

116. Convert a truth table into a Karnough map.

117. Draw a three and four variable Karnough map.

118. Simplify a Karnough map by using octets, quads, or pairs.

131. Express a decimal number in Excess - 3 code.

132. Express an Excess - 3 number as a decimal equivalent.

133. Convert Gray numbers to a decimal equivalent.

The field review for the remaining seven programs was accomplished near the end of the second year. An evaluation form was sent to every post-secondary instructor of the seven programs (See Appendix 5). They were asked to review the competencies accepted by 75% of instructors from their program areas. Thirty-one percent or 26 of 83 instructors returned the evaluation form. Six instructors made additional comments. Tables 19 and 20 list the comments.

Table 19 Added Competencies from the field review for Air Conditioning, Auto Mechanics, and Welding (N = 6)

Program	Competencies
Air Conditioning (N = 2)	1. Compute stretchout dimensions. 2. Figure the length of arcs. 3. Utilize the pythagorean theorem and trigonometric functions of sine, cosine, and tangent to determine the length of sides and angles for right triangles. 4. Use protractor to draw and measure angles. 5. Measure with and read an English and metric

	micrometers.
	6. Utilize principles of ratio and proportion.
	7. Compute the perimeter of a square, rectangle, and triangle.
	8. Compute the area of a square, rectangle, and triangle.
	9. Convert between English linear units of measure (i.e., inches to feet, yards to feet to inches, etc.)
	10. Determine ratio and proportion.
Auto Mechanics (N = 2)	1. Convert fractions to decimals.
	2. Multiply, divide, add and subtract fractions.
Welding (N = 2)	1. Add math competencies in fractions decimals, ratio and proportion.
	2. Competencies in equations would be helpful.

Table 20

Deleted Competencies from the field review for Air Conditioning, Auto Body, Auto Mechanics, Carpentry, Graphic Arts, Welding (N = 10)

Program	Competencies
Air Conditioning (N = 2)	51. Convert area measurements to metric areas.
	64. Change Centigrade to Fahrenheit.
	65. Change Fahrenheit to Centigrade.
Auto Body (N = 2)	15. Calculate the usual clearance between the door and the surrounding frame.
	20. Determine tolerance for a measurement.
	24. Calculate the five angles for steering alignment.
	26. Measure the steering axis inclination in degrees.
	27. Measure the tire-wearing angle in degrees.
Auto Mechanics	11. Calculate the tolerance for

(N = 1)	underbody alignment.
Carpentry	2. Determine complementary and
(N = 2)	supplementary angles of a triangle.
	3. Solve a problem involving similar right triangles.
	4. Solve word problems related to a right triangle.
	5. Convert a fraction to a decimal.
	44. Find the tolerance for window clearance.
	55. Find the differences in grade level between several points.
Graphic Arts	1. Find the area of a square,
(N = 1)	rectangle.
	15. Determine top and side margins of pages using percentages.
Welding	5. Convert lengths from English
(N = 3)	to metric.
	6. Convert dimension of objects from English to metric.
	7. Convert area measurements to metric areas.
	9. Convert fractions to decimals.
	19. Determine the size of a groove weld.

29. Determine the clearance between two metals to be soldered.

33. Determine the argon glow rate in ft/hr and L/min for welding various materials and joints.

34. Calculate the percent heat setting to the current range.

35. Calculate the duty cycle of resistance welding transformers.

Section 4

Resources for Teaching Exit Math Competencies

An information sheet was attached to the math competency survey instrument for all 11 selected programs. (see Appendix 1). The purpose of the information sheet was to identify the textbooks, curriculum materials, audio-visuals materials, and computer software packages that were currently being used to teach math in each of the 11 training programs.

The advisory committee (See Section 1) suggested that the handbook should include information related to the use of computers to assist in technical math instruction. Therefore, the information sheet asked several questions related to using computers. The instructors were asked if a computer was used to teach math, and if one was, what type(s) of computers were being used. As shown in Table 21, 19 of the 139 instructors contacted or 14% used computers to assist them in the instruction of math. The TRS 80 was the most predominant computer used. Thirteen of 19 instructors or 68% used the TRS 80.

A number of instructors said the related teacher used computers so they did not respond to the questions about computer use. It may be that students are using computers for math instruction, but they are doing it in a separate area under the supervision of a related teacher.

Table 21

Numbers of Instructors Using various types of Computers (N =19)

Computer Type	Number of Instructors
TRS 80	13
Apple	1
IBM-PC	4
Hand Held TI	1

The information sheet asked instructors to name all commercial software used to teach math. Table 22 listed the software that 11 instructors identified. Again, instructors implied that the related instructors were the ones using the software so the instructors did not respond.

Table 22

Commercial Software Used to Teach Math (N = 11)

Program	Software
Air Conditioning (N = 1)	Problem Solving in Algebra - Britannica
	Algebraic Expression -Educational Activities
Auto Mechanics (N = 3)	Basic Math -Comm Software (N = 1)
	Basic Math - Educulture (N = 2)
Drafting (N = 1)	Adventures in Math -IBM
	Algebraic Expressions - Educatiional Activities
	Basic Algebra Series (8 Programs) -Radio Shack
	Math Around the House - Radio Shack
	On the Road with Basic Math Skills -Radio Shack
	Problem Solving in Algebra - Radio Shack Electricity (N = 2)
	Fundamental Math 1-3, Drill & Practice -Random House

Electronics (N = 2)	Calculus, vector Addition -Tandy (N = 1)
	Utilizing Computers in Teaching Secondary Math - National Diffusion Network (N = 1)
Welding (N = 2)	IBM Private Tutor (version 2.00):
(N = 1)	1) Solving Math Word Problems, 2) Preparing for Geometry and Algebra, 3) Math Computation Skills, 4) Basic Number Concepts
	Fractions, Percentages, and Decimals -Aquarius (TRS 80) (N = 1)
	Solving Word Problems - Aquarius (TRS 80) (N = 1)

Instructors were also asked to provide information about math related software they had developed. Four instructors indicated they had developed software and most stated they would be willing to share the information. The names of the software and instructors were listed in Table 23.

Table 23

Software Developed by Instructors to Teach Math (N = 4)

Program	Software and Instructor
Auto Mechanics	Fractions and Decimals, (TRS 80), Willie Conley, Jr., Mayo SVTS
Drafting	Problem Solving in Basic and Related Math - Ralph Brown, Mayo State VTS
Electronics	Ohms Law, (TRS 80, Model 4), Bob Lanzl, Jefferson State VTS
	Solving Equations for P.E.I.R. & Variations, L.W. Ritchie, Hazard State VTS

A number of publishing companies were contacted to supply catalogs of math materials. These catalogs were analyzed, along with information provided by instructors to determine which texts and audio-visual materials would be appropriate to assist with math instruction.

Tables 24 -34 provide information about available texts. Much of the information was taken directly from the publishing catalogs and should be accurate. Other information was transferred from the instructors responses on the information sheet to the tables. Some of this information was incomplete and hard to understand. The researchers edited the information when possible. Some of

the information was listed "as is" in the tables if the judgement was made that it would be useful.

Tables 35-44 list various math related instructional materials that can be used for teaching math. As discussed above, there were problems with clarity and accuracy. However, information was listed if it was percived to be helpful.

Table 24

Math Texts For Air Conditioning

Algebra, Number Power 3, Mitchell, Contemporary Fundamentals of Technical Math, Arthur Kramer, McGraw Hill Publishers.

Geometry, Number Power 4, Mitchell and Prickel, Contemporary.

Introduction to Technical Math, Radford Rychlick, PWS.

Modern Refrigeration and Air Conditioning, Althouse and Turnquist, Goodheart-Willcox Publishers.

Practical Problems in Mathematics for Heating and Cooling Technicians, Russell Devore, Delmar Publishers.

Principles of Air Conditioning, 4th Edition, V. Paul Lang, Delmar Publishers.

Refrigeration and Air Conditioning Technology: Concepts, Procedures, and Troubleshooting Techniques, Wm. Whitman & Wm. Johnson, Delmar Publishers.

Table 25

Math Texts For Auto Body

Auto Body Repairing and Repainting, Bill Tobolt, Goodheart-Wilcox Publishers.

Auto Service and Repair, Martin W. and Martin J. Stockel, Goodheart-Wilcox Publishers.

Basic Mathematics Simplified, Olivo/Olivo, Delmar Publishers.

Basic Vocational-Technical Math, Olivo/Olivo, Delmar Publishers.

Mathematics for Technical Occupations, Bila/Bottoriff/Merritt/Ross, Winthrop Publishers.

Table 26

Math Texts For Auto Mechanics

Auto Mechanics Fundamentals, Stockel/Stockel, Goodheart-Willcox.

Automotive Encyclopedia, Goodheart-Willcox.

Automotive Principles and Service, Reston.

Automotive Testing and Diagnosis, Sun Electric Corp.

Basic Vocational-Technology Mathematics, Olivo/Olivo, Delmar Publishers.

Diesel Fundamentals, Service and Repair, Bill Tobolt, Goodheart-Wilcox Publishers.

Fundamentals of Technical Math, Arthur Kramer, McGraw Hill Publishers.

Introduction to Technical Math, Radford/Rychlick, PWS.

Mathematics for Auto Mechanics, T.G. Hendrix and C.S. LaFevor.

Modern Automotive Mechanics, James E. Duffy, Goodheart-Wilcox Publishers.

Practical Problems in Mathematics for Auto Mechanics, George Moore, Delmar Publishers.

Table 27

Math Texts For Carpentry

Applied General Mathematics, Robert D. Smith, Delmar Publishers.

Basic Vocational-Technical Mathematics, Olivo/Olivo, Delmar Publishers.

Carpentry, L. Koel, AmericanTech Publishers Inc.

Carpentry, Gaspar J. Lewis, Delmar Publishers.

Framing, Sheating, and Insulation, Delmar Publishers.

Fundamentals of Carpentry I, W. E. Durbahn, AmericanTech Publishers Inc.

Fundamentals of Carpentry II, W. E. Durbahn, AmericanTech Publishers Inc.

Mathematics for Carpenters, Robert Brandford, Delmar Publishers.

Mathematics for Trade and Industrial Occupations, Wm. W. Rogers, Silver Burdett Co.

Modern Carpentry, Willis H. Wagner, Goodheart-Wilcox Publishers.

Practical Problems in Mathematics for Carpenters, Harry C. Huth, Delmar Publishers.

Related Mathematics for Carpenters, P. L. Reband, AmericanTech Publishers Inc.

Technical Mathematics, Lewis, Delmar Publishers.

Woodworking for Industry, John L. Feirer.

Table 28

Math Texts For Drafting

Applied Descriptive Geometry, Susan Stewart, Delmar Publishers Inc.

Architecture Design and Engineering Drawing, McKnight Publishers.

Architectural Drafting and Design, A. Jefferis & D. Masden, Delmar Publishers Inc.

Architecture and Residential Drawing and Design, C. E. Kicklighter, Goodheart-Wilcox Publishers.

Basic Mathematics Simplified, Olivo and Olivo, Delmar Publishers.

Basic Mathematics for the Trades, Benjamin Cummins, Mowbray Publishers

Computer Aided Design and Drafting, M. Zandi, Delmar Pub.

Engineering Drawing and Design, 2nd and 3rd Edition. Jensen, and Helsel, McGraw Hill Publishers.

Introduction to Technical Drawing, (Metric), Delmar Pub.

Mathematics for Trade and Industrial Occupations, Wm. Rogers, Silver Burdett Publishers.

Plane and Spherical Trigonometry, F.A. Ayers Jr., McGraw Hill

Practical Problems in Math for Mechanical Drawing, Larkin, Delmar Publishers.

Practical Shop Math, T.C. Power, McGraw Hill Publishers.

Principles of Mechanical Drawing, Parr, McGraw Hill Publishers

Simplified Engineering for Architects and Builders.

Technical Drawing, 7th and 8th Edition, Giesecke, Spencer and Mitchell, Macmillan Publishers.

Technical Drawing and Design, Goetsch, Delmar Publishers

Technical Mathematics, Calter, Prentice Hall Publishers.

Technical Shop Mathematics, J. Anderson, Industrial Press.

Vocational and Technical Math, R.D. Smith, Delmar Publishers.

World Metric Standards for Engineering, Kverneland, Industrial Press.

Table 29

Math Texts For Electricity

Alternating Current Fundamentals, J.R. Duff & S. Hernan
Delmar Publishers Inc.

Basic Electronics, Grob, McGraw Hill, 5th Edition.

Basic Mathematics for Electricity and Electronics, Singer & Forester, McGraw Hill, 5th Edition.

Basic Mathematics for Electronics, N.M. Cook, McGraw Hill.

Direct Current Fundamentals, O.E. Loper, Delmar Publishers.

Electrical Control for Machines, Kenneth Rexford, Delmar Publishers, 3rd Edition (New for 1987).

Electrical Power, Joe Kaiser, BSEE, Goodheart-Wilcox Company, Inc.

Electrical Principles and Practices, J. Adams, McGraw Hill.

Electrical Wiring Commercial, Mullin and Smith, Delmar Publishers.

Electrical Wiring Residential, Mullin and Smith, Delmar Publishers.

Electricity I:Devices Circuits and Materials, T.S. Kubula, Delmar Publishers Inc.,4th Edition.

Electricity II: Devices, Circuits, and Materials, T.S. Kubula, Delmar Publishers Inc., 4th Edition.

Electricity III, Motors, Generators, and Controls, N. Alerich.

Electricity IIII: Motors, Controls, Alternators, Delmar Publishing Inc., 4th Edition.

Electro Mechanisms and Devices, P. Robertson, R. Hunter, R. Allan, Delmar Publishers.

Electronic Wiring Industrial, Smith, Delmar Publishers.

Electronics for Industrial Electricians, S.L. Herman, Delmar Publishers Inc.

Industrial Electricity, John Nadon, Bert Gelmine, Edward McLaughlin, Delmar Publishers.

Mathematics for Electricity and Electronics, Gene Waring, Delmar Publishers Inc.

Practical Problems in Mathematics for Electricians, C. Garrard, F.Boyd, & S. Herman, Delmar Publishers Inc.

Shop Mathematics at Work, Walton and Rogers, 3rd Edition.

Success in Mathematics-Diagnostic Test, Motivational Development Co.

Understanding Electricity and Electronics, Buban and Shmitt, McGraw Hill Publishers.

Table 30

Math Texts For Electronics

Background Math for a Computer World, Wiley and Ashley.

Basic Electricity Series, Radio Shack.

Basic Math for Trades and Technology, Cleaves and Hobbs, Prentice Hall.

Basic Mathematics for Electricity and Electronics, McGraw Hill.

Basic Mathematics for Electronics, Cooke,Adams,Dell, McGraw Hill, 5th Edition.

Basic Programming for Engineers and Technicians, Frances Guldner, Delmar Publishers.

Circuit Analysis Methods, Olivo and Dale, second edition.

Electronic Mathematics, Thomas Power, Delmar Publishers Inc.

Fundamentals of Electronic Math, Carl Rader, Delmar Publishing Co.

Fundamentals of Technical Math With Calculus, Arthur Kramer, McGraw Hill.

Introduction to Applied Physics, Harris, Hemmelburg, McGraw Hill, 4th Edition.

Introduction to Electronics: A Practical Approach, Earl Gates, Delmar Publishers, (New for 1987).

Mathematics for Basic Electronics, Grob, McGraw Hill.

Math for Electricity and Electronics, Gene Waring, Delmar Publishing Inc.

Mathematics Outline and Review Problems for Basic Electronics

Grob, McGraw Hill, 4th Edition.

Modern Electronic Mathematics, Richard Sullivan, Delmar Publishers Inc.

Practical Problems in Math for Electronic Technology, Sullivan, Delmar Publishers Inc.

Technical Math and Calculus, Rice and Strange, Prindle Weber, and Schmidt.

Technician's Guide to Fiber Optics, Donald Sterling, Delmar Publishing, (New for 1987).

Scientific Calculator Applications.

Table 31

Math Texts For Graphic Arts

Basic Graphics Tutor for Compugraphic Typesetters

Graphic Arts Fundamentals, John R. Walker, Goodheart-Wilcox

Graphic Arts Technology, John R. Karsnitz, Delmar Publishers

Math for Printers Mathematics Skill Book 5500, 6600, 7700, 8800, Steck & Vaughn Co.

Photo-Offset Lithography, Z. A. Prust, Goodheart-Wilcox Publishers.

Practical Mathematics, American Technical Society.

Practical Problems in Mathematics for Graphic Arts, Vermeersch/Southwick, Delmar Publishers.

Practical Problems in Mathematics for Printers, James P. De Luca, Delmar Publishers.

Table 32

Math Texts For Machine Shop

Advanced Machine Technology, C.T. Olivo, Delmar Publishers Inc.

Applied General Mathematics, Robert Smith, Delmar Publishers Inc.

Machine Tool Technology and Manufacturing Processes, C.T. Olivo, Delmar Publishing Inc.

Math for Machine Technology, Robert Smith, Delmar Publishers Inc.

Mathematics of the Shop, F.J. McMackin/J.H. Shaver/R.E. Weber/R.D. Smith, Delmar Publishers Inc.

Modules Covering Machine Shop Practices, Department of Vocational Education, Frankfort, Kentucky.

Practical Problems in Mathematics for Machinists, Edward Hoffman, Delmar Publishing Inc.

Practical Problems in Mathematics - Metric System, F. R. Schell, Delmar Publishers.

Practical Shop Mathematics, Thomas Power, Delmar Publishers Inc.

Technical Mathematics, Harry Lewis, Delmar Publishers Inc.

Technical Shop Mathematics, Anderson, Industrial Press.

Table 33

Math Texts For Masonry

Basic Vocational-Technical Mathematics, 5th Ed., Olivo/Olivo, Delmar Publishers.

Modern Masonry, Clois E. Kicklighter, Goodheart-Wilcox Publishers.

Practical Problems in Mathematics for Masons, John E. Ball, Delmar Publishers.

Vocational-Technical Mathematics, Robert D. Smith, Delmar Publishers.

Table 34

Math Texts For Welding

Basic Arc Welding, Smaw, Griffen, Roden Griggs. Basic Blue Print Reading and Sketching, Olivo/Pane, Delmar Publishers.

Basic Vocational-Technical Mathematics, Olivo/Olivo, Delmar Publishers.

Blue Print Reading for Welders, A. E. Bennett and Louis J. Six, Delmar Publishers.

Industrial Welding Procedures, Frank Schill/Bill Matlock, Delmar Publishers.

Modern Metalworking, John R. Walker, Goodheart-Wilcox Publishers.

Modern Welding, Althouse/Turnquist/Bowditch/Bowditch,

Goodheart-Wilcox Publishers.

Practical Problems in Mathematics for Welders, Frank Schell/Bill Matlock, Delmar Publishers.

Vocational-Technical Mathematics, Robert D. Smith, Delmar Publishers.

Welding Fundamentals, R. J. Madsen, AmericanTech Publishers Inc.

Welding Principles and Applications, Jeffus and Johnson, Delmar Publishers.

Welding Skills, Giachino/Weeks, AmericanTech Publishers Inc.

Welding Technology, Kennedy, Howard W. Sams & Co.

Table 35

Math Materials for Air Conditioning

Overhead Transparencies (Physics), Central Scientific.

Refrigeration And Air Conditioning Technology

Table 36

Math Materials For Auto Body

Curriculum Development Materials, University of Kentucky.

Mitchell Manual/Body and Mechanical Parts Service and Repair, Mitchell Information Services, Inc.

Table 37

Math Materials For Auto Mechanics

Automotive Mechanics, Crouse/Anglin.

Basic Vocational-Technology Mathematics, Olivo/Olivo, Delmar Publishers.

Chart Books, AC-Delco, Anderson, Indiana.

Fundamentals of Technical Math, Arthur Kramer, McGraw Hill Publishers.

Introduction to Technical Math, Radford/Rychlick, PWS.

Mathematics, Silver Burdett Co.

Table 38

Math Materials For Carpentry

CBVE modules, Kentucky Department of Vocational Education.

Number Power 4: Geometry, Contemporary

Table 39

Math Materials For Drafting

Algebra and Trigonometry Series, Creative Visuals

Descriptive Statistics, Heath Company

Fundamentals of Geometry I and II, Creative Visuals

Intermediate Algebra, Heath Company

Machinery's Handbook and Use of Handouts by Jones

Industrial Press Publications

Mathematics for Science and Technology, Heath Company

Measuring Tools Explained, Bergwall, (Audio Visual)

Trigonometry, Heath Company

Table 40

Math Materials For Electricity

Basic Electricity Program, Audio Active Inc.

Basic Electricity and Electronics Explained, DC-AC, Bergwall (Audio Visual).

Bergwall Productions Audio Visual on Rotating Machinery

Bergwall Productions Inc.,: 801, 802, 803, 804, 806, 812, & 813.

Basic Electricity and Direct Current, National Innovative Media Co. (Video).

Basic Electricity and Electronics: Reactive Circuits, National Innovative Media Co. (Video).

Contemporary Number Power, J.Howett, Contemporary Books Inc.

D.C. Motors, and Single Phase AC Motors, National Innovative Media Co. (Video).

Electronic Circuits, Heathkit, Zenith.

Table 41

Math Materials For Electronics

D.C. Circuits -A.C. Circuits, Bergwall.

Digital Electronics, Heath.

Digital Principles and Applications, McGraw Hill.

Electronics Circuits, Heath.

Electronics Communications, McGraw Hill.

Fiber Optics, Heath.

Laser Technology, Heath.

Microcomputers, Heath Kit.

Microprocessors, Heath.

850 Digital Electronics, Bergwall (Audio Visual).

851 Digital Electronics, Bergwall (Audio Visual).

870 Digital Codes, Bergwall (Audio Visual).

880 Robotics Explained, Heath (Audio Visual).

870 Digital Codes, Heath (Audio Visual).

805 Reactive Circuits, Heath (Audio Visual).

807 Transistors, Heath (Audio Visual).

802 Basic Electricity-AC, Bergwall (Audio Visual).

801 Basic Electricity-DC, Bergwall (Audio Visual).

Solid State Electronics, Bobbs Merrill.

Vectors and Vector Analysis, and Rotating Vectors, Bergwall (Audio Visual).

Table 42

Math Materials For Graphic Arts

Modern Graphic Arts Paste-Up, American Technological Society.

Photo-Offset Fundamentals, McKnight Publishing Co. Pica, Module 2.4.

Pica, Pica Foundation of Clemson University.

Table 43

Math Materials For Machine Shop

Geometric Form and Positional Tolerancing, (video), Teaching Aids Inc.

How to Read a Metric Micrometer, (video), Teaching Aids Inc.

How to Read a Vernier Caliper, (video), Teaching Aids Inc.

Use and Care of Micrometer, (video), Teaching Aids Inc.

Table 44

Math Materials For Welding

Welding Skills Workbook, Jonathan Gosse.

Section 5

The first four sections of this handbook provide information that allow identification, evaluation and verification of math skills which should be taught in eleven post-secondary vocational programs. This information is useful, if some instruction is provided on how to develop a practical improvement plan. Section 5 provides an indication of how the information can be most efficiently and effectively used to improve the eleven vocational programs.

Discussion

All the listings and comments were based on the methods used in the project to determine competencies. The project methods and related decisions must be carefully examined to determine the significance of the handbook information.

Using the T.A.B.E. to define "basic" math competencies, the instructors and related teachers needed to be familiar with the content of the test, as well as understand that the student math skills developed through course instruction were defined as "exit" math competencies. Some competencies could then have been rejected because of confusion over what were basic or exit competencies. This should not have affected the listings often since the decision rule for how competencies were selected allowed for some error in the recognition of competencies (i.e., 2 out of 10 instructors could reject a competency and the competency would appear in the list as needed in a program).

There is another factor to consider when reviewing the

lists of competencies selected. If the directions to the instructors to select more advanced or exit competencies were not kept in mind as instructors selected competencies, then all recognizable competencies could have been included in the listings. This would result in listings that contained both basic and exit competencies.

The math competencies used in the surveys were identified by analyzing occupational content from textbooks. The competencies were then put into a general math format and added to the survey instruments. For most competencies this method was appropriate. However, for some competencies this presented a problem. Changing a number of math competencies that were closely linked to content to a general math format seemed to change how difficult they appeared. Many of the competencies seemed to become "basic" when separated from the content. A great deal of thought went into what to do about the situation. The decision was made to list these competencies in a general math format on the survey instruments and let the evaluators decide. Many of the competencies remained on the competency lists throughout the evaluations and are listed in Section 2. These competencies appear basic, but are complex when combined with content. There is a concern about the other competencies that were rejected. Would they have been included on the final listings if linked to content? Did the evaluators recognize how the competencies linked with the content? These questions cannot be answered, but there is a concern over how

this problem affected the handbook results.

A number of comments received during the project suggested that industry should have taken a part in identifying the competencies. Using instructors as representatives of industry was a good decision, provided the instructors are extensions of industry through their recent industrial links and experiences. However, there is some question as to whether this assumption is correct. There is no way of knowing whether or not the decision to make instructors industry representatives had an adverse or positive effect on the validity of the information.

The survey instruments were developed by the researchers to give instructors a starting point to select competencies. It was expected that instructors would accept some, reject many, and add a number of competencies. This did not happen. There was a wide range of acceptance of the competencies. For electronics most competencies were accepted, while the electricity instructors rejected most of the competencies. Also, there were not very many competencies added by the evaluators. It was surprising that competencies were not added, since in many of the programs, the competencies on the survey instrument were rejected. There seemed to be more interest in adding competencies during the field review, after the survey instruments were analyzed and competencies categorized. It is not known if the researchers were accurate in developing some of the surveys, or if instructors had difficulty in separating content from math competencies.

There is no way to determine the effects of these factors on the results.

From the instructors' viewpoint, the competencies that are listed on the "needed" list should represent a large percentage of the competencies needed in the eleven programs. However, they do not include all of the competencies. Competencies needed in one local area served by a vocational school may not show up on the list because others did not see the need for and did not select the competency. This does not mean the information is invalid. It means the listings and related information are designed to be complete when considering the statewide area but not complete when considering local situations.

Using the Competency Information

The discussion about possible limitations of the competency lists indicates that this handbook must be used carefully. The competencies needed in a program are the combination of the basic and exit math competencies needed for employment. The combination of these competencies include the math competencies generally needed to succeed in a particular occupation over a large geographic area and those competencies needed to succeed at work in local areas served by training programs. Also, additional competencies may be needed to meet the educational aspirations, promotional possibilities, and career mobility of the student. Each vocational training program may have different math competencies because of particular program situations.

The instructors' challenge is to determine the appropriate mix of competencies which provide students with backgrounds to achieve successful careers.

Suggestions for Using the Information

The information in this handbook has implications for programs, students, and industry. Therefore, any possible changes due to comparisons of what is being done to what is needed according to handbook information should be shared with advisory committee members, relevant industry personnel, and other instructors from similar programs. The handbook will help to analyze the reasons for teaching competencies and help in arriving at a complete competency list.

The following suggestions are made when using information from this handbook. Use one or more of the suggestions and do not limit how the information can be combined with other ideas for improvement.

(1) Compare the math competencies taught in a program with the competencies listed in Section 2. If a competency is found on the list and is taught in the program, then the program in question has included a competency that at least 75% of the other instructors in Kentucky agree is necessary. The examples in Appendix 4 will be helpful to define particular competencies if the program is drafting, electricity, electronics, or machine shop.

(2) If a program is drafting, electricity, electronics, or machine shop, Table 4 of common competencies in Section 2 should be observed. If there are common competencies that

are taught in one of the programs, then the other three programs can be used as resources to show how the common competencies are taught and evaluated. Also, it may be practical to combine students from the four programs to learn some of the common competencies.

(3) Compare the math competencies taught in a program with the program specific competencies listed in Section 2. If a competency is listed in Section 2 but is not included in the program curriculum, there should be study of why the competency is not taught.

(4) Compare the math competencies taught in a program with the rejected competencies listed in Appendix 3. If a rejected competency from the appendix is not taught in a program, 75% of the instructors in Kentucky also rejected the competency.

(5) Compare the math competencies taught in a program with the rejected competencies listed in Appendix 3. If a rejected competency is taught in a program because it is basic to understanding course material the competency should continue to be addressed in instruction. However, if the competency is more advanced than a basic competency there should be a study of why the competency is taught. Again, the study should include advisory committee members, representatives from local industries, and other instructors from like programs. (6) If there are competencies taught in a program that are not on any of the lists in the handbook an evaluation should be undertaken of why they are included in

the curriculum. Additional competencies may be needed to deal with local situations.

(7) Look at the tabulations in Appendix 2 to determine how instructors rated particular competencies.

It may be worthwhile to meet with other instructors to discuss some of the competencies that were accepted by a number of instructors but rejected by the 75% rule. Perhaps some of the limitations discussed previously affected the instructors' responses to the survey instrument.

(8) Section 3 listed competencies that some instructors thought should be added or deleted. These competencies may be considered for inclusion in an instructional program. However, any competencies selected should be verified by other instructors of the same programs or advisory committees.

(9) The resource lists of Section 4 can be observed to determine possible resources for teaching exit math competencies. These lists are not complete and should be used as a starting point for discussion. It would be helpful to share information with other instructors to develop a more complete listing.

Appendix 1

Surveys and Information Sheet

INFORMATION SHEET

NAME _____

SCHOOL _____

PHONE NUMBER _____

1. LIST THE MAJOR UNITS IN YOUR COURSE.
   NOTE - YOU MAY WANT TO INCLUDE YOUR COURSE OUTLINE TO ADD EXPLAINATION.

   _____

   _____

   _____

2. ARE YOU A DAY OR EVENING INSTRUCTOR _____ ?

3. DO YOU USE A COMPUTER TO ASSIST IN TECHNICAL MATH INSTRUCTION _____ (YES OR NO)?

4. IF YOU ANSWERED YES TO #3, WHAT TYPE OF COMPUTER(S) DO YOU USE IN YOUR PROGRAM TO TEACH MATH?

   _____

   _____

   _____

5. HAVE YOU DEVELOPED SOFTWARE TO ASSIST WITH TECHNICAL MATH INSTRUCTION _____ (YES OR NO)?

6. IF YOU ANSWERED YES TO #5, WOULD YOU BE WILLING TO SHARE THE SOFTWARE YOU HAVE DEVELOPED _____ (YES OR NO)?

7. LIST THE TITLES OF THE SOFTWARE YOU DEVELOPED AND ARE WILLING TO SHARE. PLEASE NOTE THE TYPE OF COMPUTER USED.

   _____

   _____

8. LIST ANY COMMERCIAL SOFTWARE (TITLE, PUBLISHER) YOU ARE USING TO TEACH MATH: ALSO, PLEASE NOTE THE COMPUTER USED WITH THE SOFTWARE.

---

9. WHAT OTHER RESOURCE MATERIALS ARE YOU USING TO TEACH TECHNICAL MATH?

TEXTBOOKS: (PLEASE LIST TITLE, AUTHOR, PUBLISHER)

CURRICULUM MATERIALS: (PLEASE LIST TITLE, PUBLISHER)

AUDIO - VISUAL MATERIALS: (PLEASE LIST TITLE, DEVELOPER)

OTHER MATERIALS:

NOTE: YOU MAY NEED TO ATTATCH ADDITIONAL SHEETS OF PAPER TO DESCRIBE THE RESOURCES YOU USE TO TEACH MATH.

EXIT MATH COMPETENCIES

FOR

AIR CONDITIONING

Directions: Circle the number which indicates whether or not a student needs the competency when exiting your program. Please do not leave any item unanswered.

		NEEDED	NOT NEEDED
1.	Add, subtract, multiply on a number line. ---	1	2
2.	Represent the products of two numbers on a graph. ----------	1	2
3.	Find the value of a radius vector graphically. ----------	1	2
4.	Represent trigometric functions by graphing.-	1	2
5.	Find the values of x and y on a graph. ------	1	2
6.	Solve two simultaneous equations by graphing.	1	2
7.	Convert a whole number to a positive power of ten. Example : (46 = 4.6 x ?) ----------	1	2
8.	Add, subtract, multiply, and divide positive and negative powers of ten. Example : (4x10) + (6x10) = ? ----------	1	2
9.	Square a monomial. Example : (2a^{8}) = ? --	1	2
10.	Cube a monomial. Example : (3a b) = ? --	1	2
11.	Take the square root of a monomial. Example : (4 = ?) ----------	1	2
12.	Find the cube root of a monomial. Example : (8 = ?) ----------	1	2
13.	Square a binomial. Example : (a - b) = ?	1	2
14.	Take the square root of a trinomial. Example : (a + 2ab + b) = ? ----------	1	2
15.	Divide numbers with exponents. Example : (a - a) = ? ----------	1	2

		NEEDED	NOT NEEDED
16.	Multiply a number with an exponent by an exponent. Example : (a) = ? ----------	1	2
17.	Multiply a fraction with an exponent by an exponent. Example : (x / y) = ? ----------	1	2
18.	Express numbers with negative exponents as numbers with positive exponents. Example : (a b) = ? ----------	1	2
19.	Find the values of numbers with fractional exponents. Examples : (16) = ? ----------	1	2
20.	Simplify radicals containing fractions. Example : 16/5 ----------	1	2
21.	Add and subtract radicals. Example : 2 2 + 5 2 = ? ----------	1	2
22.	Group terms in an equation. ----------	1	2
23.	Determine signs in a complex equation. ------	1	2
24.	Solve equations with one unknown. ----------	1	2
25.	Solve equations by transposing. Example : (e + 4) = 12 e = ? ----------	1	2
26.	Solve an equation by canceling a term. Example : (x - y = 2 + x), y = ? ----------	1	2
27.	Check solutions for equations. ----------	1	2
28.	Form equations from observed data. ----------	1	2
29.	Solve a problem using a formula with knowns and one unknown expressed in the same unit. Example : a problem about ohm's law. ----------	1	2
30.	Solve a problem involving 2 formulas, 3 or more knowns, and one unknown. ----------	1	2
31.	Solve a problem involving 3 formulas, 3 or more knowns, and one or more unknowns.--	1	2
32.	Solve a quadratic equation. Example : (x -25 = 0), x = ? ----------	1	2
33.	Solve equations with the quadratic formula.		

		NEEDED	NOT NEEDED
	Example : (x - 10x + 16 = 0), x = ? -------	1	2
34.	Solve quadratic equations by graphing.-------	1	2
35.	Factor a simple equation. -------------------	1	2
36.	Find the prime factors of equations. Example : (3ax + 6ax + 3ay) = ? ----------	1	2
37.	Find the product of two equations. Example : (a + b) (a - b) = ? -------------	1	2
38.	Divide two quadradic equations. Example : $\frac{b + c}{a - b}$ = ? ----------	1	2
39.	Solve simultaneous linear equations by addition and subtraction. -------------------	1	2
40.	Solve simultaneous equations by comparison.--	1	2
41.	Solve fractional form simultaneous equations. Example : (x/4 + y/3 = 7/12, x/2 -2y/3 = 5/6), x = ? ----------	1	2
42.	Determine complimentary and supplementary angles of a triangle. ----------	1	2
43.	Determine dimensions of a drawing to scale.--	1	2
44.	Calculate the area and circumference of a circle. ----------	1	2
45.	Determine metric numbers that represent the SI prefix symbols. ----------	1	2
46.	Determine metric prefix names for prefix symbols. ----------	1	2
47.	Find the equivalent value in metrics of a value with a prefix symbol.----------	1	2
48.	Determine customary lengths for selected metric lengths. ----------	1	2
49.	Convert lengths from English to metric.------	1	2
50.	Convert dimensions of objects from English to metric. ----------	1	2

		NEEDED	NOT NEEDED
51.	Convert area measurements to metric areas. --	1	2
52.	Compute metric volumes. ----------	1	2
53.	Convert customary dimensions to metric dimensions and calculate the volume in metric units. ----------	1	2
54.	Use vector diagrams to find instantaneous values in an AC circuit. ----------	1	2
55.	Write equations for voltage and current using a circuit. ----------	1	2
56.	Draw vector diagrams of circuits. ----------	1	2
57.	Find the circumference for a circle.---------	1	2
58.	Find the perimeter of a polygon. ----------	1	2
59.	Find the area of a circle. ----------	1	2
60.	Subtract with degrees, minutes, and seconds.-	1	2
61.	Determine sizes of angles on drawings. ------	1	2
62.	Find the area of a circle, triangle, square, parallelogram and rectangle. ----------	1	2
63.	Reason what occurs from a formula when variables are increased/decreased. Example : I = 120 X ----------	1	2
64.	Change Centagrade to Farenheit. ----------	1	2
65.	Change Farenheit to Centigrade. ----------	1	2
66.	Solve problems using >, <, >, <. ----------	1	2
67.	Convert prefixes with units to numbers with units. Example : megaohms to 1,000,000 ohms ----------	1	2
68.	Convert prefixes with units to powers of ten with units. Example : Kvolts to .1 x 10 volts----------	1	2
69.	Solve problems with prefixes, units, numbers. ----------	1	2

		NEEDED	NOT NEEDED
70.	Solve problems with ditterent units. Example : Torque (pound - teet) = hp x 5252 / rpm	1	2
71.	Read x and y values from complex graphs (five or more lines).	1	2
72.	Inrepolate readings on meter scales.	1	2
73.	Determine the distance relationship of parts from a drawing.	1	2
74.	Calculate proportions ot solids to liquids. Example : 5 lbs. per 10 gallon	1	2
75.	Measure diameters to close tolerances.	1	2
76.	Measure clearances to close tolerances.	1	2
77.	Calculate percentages ot quantities. Example : Relative humidity.	1	2

EXIT MATH COMPETENCIES

FOR

AUTO BODY

Directions : Circle the number which indicates whether or not a student needs the competency when exiting your basic auto body program. Please do not leave any item unanswered.

		NEEDED	NOT NEEDED
1.	Add and subtract in inches. ----------	1	2
2.	Find the square inches of a rectangle. -	1	2
3.	Determine metric numbers that represent the SI prefix symbols. ----------	1	2
4.	Determine metric prefix names for prefix symbols. ----------	1	2
5.	Find the equivalent value in metrics of a value with a prefix symbol. ----------	1	2
6.	Determine customary lengths for selected metric lengths. ----------	1	2
7.	Convert lengths from English to metric.	1	2
8.	Convert dimensions of objects from English to metric. ----------	1	2
9.	Convert area measurements to metric areas.	1	2
10.	Convert fractions to decimals. --------	1	2
11.	Convert decimals to fractions. --------	1	2
12.	Add and subtract using fractions. ------	1	2
13.	Find the area of a square, rectangle. ---	1	2
14.	Calculate the tolerance for underbody alignment. ----------	1	2

	NEEDED	NOT NEEDED
15. Calculate the usual clearance between the door and the surrounding frame. --------	1	2
16. Calculate the correct air pressure for spraying paint. ----------	1	2
17. Calculate the amount of fiberglass and resin needed to form an auto body. -----	1	2
18. Find the diameter of a circle. ---------	1	2
19. Find the radius of a circle. ----------	1	2
20. Determine tolerance for a measurement.--	1	2
21. Solve problems using percentages. ------	1	2
22. Determine the sizes of angles on drawings.	1	2
23. Find the diagonal of a square. ----------	1	2
24. Calculate the five angles for steering alignment. ----------	1	2
25. Calculate the tolerance for mash in a car frame. ----------	1	2
26. Measure the steering axis inclination in degrees.----------	1	2
27. Measure the tire-wearing angle in degrees.	1	2
28. Determine the tolerances for frame adjustment. ----------	1	2
29. Measure frames and car bodies using fram guages. ----------	1	2
30. Determine sheet metal tolerances from a blueprint. ----------	1	2
31. Determine the minimum pipe size needed for a compressing outfit. ----------	1	2
32. Calculate an estimate of the cost of repair work for a job. ----------	1	2

EXIT MATH COMPETENCIES

FOR

AUTO MECHANICS

Directions : Circle the number which indicates whether or not a student needs the competency when exiting your basic auto mechanics program. Please do not leave any item unanswered.

		NEEDED	NOT NEEDED
1.	Add, subtract, multiply, and divide tractions. ----------	1	2
2.	Add and subtract in inches. ----------	1	2
3.	Convert lengths from English to metric.	1	2
4.	Convert dimensions of objects from English to metric. ----------	1	2
5.	Convert area measurements to metric areas.	1	2
6.	Convert fractions to decimals. --------	1	2
7.	Convert decimals to fractions. --------	1	2
8.	Find the diameter of a circle. ---------	1	2
9.	Find the radius of a circle. ----------	1	2
10.	Determine tolerance for a measurement.--	1	2
11.	Calculate the tolerance for underbody alignment. ----------	1	2
12.	Solve problems using percentages. ------	1	2
13.	Determine the sizes of angles on drawings.	1	2
14.	Calculate the five angles for steering alignment. ----------	1	2
15.	Calculate the tolerance for mash in a car frame. ----------	1	2

		NEEDED	NOT NEEDED
16.	Measure the steering axis inclination in degrees.	1	2
17.	Measure the tire-wearing angle in degrees.	1	2
18.	Calculate an estimate of the cost of repair work for a job.	1	2
19.	Read a conventional micrometer.	1	2
20.	Read a metric micrometer.	1	2
21.	Read a dial indicator.	1	2
22.	Convert temperature readings from Farenheit to Celsius.	1	2
23.	Use Ohm's law to determine the amount of resistance in a circuit.	1	2
24.	Determine an engine's piston displacement.	1	2
25.	Determine engine displacement or size.	1	2
26.	Determine the work needed to raise an engine, using the formula for work.	1	2
27.	Determine the power needed to move a given car.	1	2
28.	Determine the engine compression ratio.	1	2
29.	Determine the compression pressure of an engine cylinder.	1	2
30.	Calculate the indicated horsepower.	1	2
31.	Calculate the frictional horsepower.	1	2
32.	Calculate net horsepower.	1	2
33.	Calculate gross horsepower.	1	2
34.	Calculate taxable horsepower.	1	2
35.	Calculate volumetric efficiency.	1	2
36.	Calculate mechanical efficiency.	1	2
37.	Calculate thermal efficiency.	1	2

		NEEDED	NOT NEEDED
38.	Determine engine torque. ----------	1	2
39.	Read a dwell meter. ----------	1	2
40.	Read a tachometer. ----------	1	2
41.	Read a refractometer. ----------	1	2
42.	Read a vacuum guage. ----------	1	2
43.	Read an engine analyzer. ----------	1	2

PLEASE ADD ADDITIONAL COMPETENCIES YOU BELIEVE ARE NEEDED.

44. ----------

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45. ----------

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46. ----------

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47. ----------

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48. ----------

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49. ----------

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50. ----------

EXIT MATH COMPETENCIES

FOR

CARPENTRY

Directions : Circle the number which indicates whether or not a student needs the competency when exiting your basic carpentry program. Please do not leave any item unanswered.

	NEEDED	NOT NEEDED
1. Square a number. ----------	1	2
2. Determine complementary and supplementary angles of a triangle. ----------	1	2
3. Solve a problem involving similar right triangles. ----------	1	2
4. Solve word problems related to a right triangle. ----------	1	2
5. Convert a fraction to a decimal. -------	1	2
6. Compute horizontal and vertical spacing of an object. ----------	1	2
7. Determine metric numbers that represent the SI prefix symbols. ----------	1	2
8. Determine metric prefix names for prefix symbols. ----------	1	2
9. Find the equivalent value in metrics of a value with a prefix symbol. ----------	1	2
10. Determine customary lengths for selected metric lengths. ----------	1	2
11. Convert units in the metric system. Example : M to mm. ----------	1	2
12. Convert lengths from metric to English.	1	2
13. Calculate the areas of objects from English to metric. ----------	1	2

	NEEDED	NOT NEEDED
14. Convert lengths from metric to English.	1	2
15. Convert dimensions of objects from English to metric. ----------	1	2
16. Convert areas measurements to metric areas.	1	2
17. Compute metric volumes. ----------	1	2
Find the correct drafting scale ratio for:		
18. Site plans. ----------	1	2
19. Plot plans. ----------	1	2
20. Elevation plans. ----------	1	2
21. Construction plans. ----------	1	2
22. Find the perimeter of any polygon. ----	1	2
23. Solve problems using percentages. -----	1	2
24. Subtract with degrees, minutes, and seconds. ----------	1	2
25. Find decimal equivalents of minutes and seconds. ----------	1	2
26. Find minute and second equivalents of decimals. ----------	1	2
27. Determine sizes of angles on drawings. -	1	2
28. Find the area of a triangle, square, parallelogram, and a rectangle. -------	1	2
29. Find the diagonal of a square. --------	1	2
30. Read a moisture meter. ----------	1	2
31. Find the board footage needed for construction. ----------	1	2
32. Estimate the number and size of floor joists. ----------	1	2
33. Use an archetects scale to check the dimensions on a scaled drawing. -------	1	2
34. Use a folding rule to scale a plan. ---	1	2
35. Figure the normal dead load. ----------	1	2
36. Figure the live load. ----------	1	2

		NEEDED	NOT NEEDED
37.	Estimate the number of studs needed for a wall or partition. ----------	1	2
38.	Estimate the amount of wall sheathing needed for the structure. ----------	1	2
39.	Use a framing square to estimate the approximate length of rafters. --------	1	2
40.	Calculate the length of a common rafter using the table on the framing square.	1	2
41.	Calculate the common difference of jack rafters with the third and fourth line of the rafter table. ----------	1	2
42.	Calculate the number of rafters required for a gable roof. ----------	1	2
43.	Estimate the amount of roofing materials needed using a carpenter's rule. ------	1	2
44.	Find the tolerance for window clearance.	1	2
45.	Estimate the amount of siding needed for a structure. ----------	1	2
46.	Determine the amount of heat lost through certain materials. ----------	1	2
47.	Determine the amount of insulation needed for a structure. ----------	1	2
48.	Estimate the number of board feet of strip flooring needed to cover a given area.	1	2
49.	Calculate the number and size of risers and treads for a given stair run. -----	1	2
50.	Calculate the area of a flue. ---------	1	2
51.	Figure the cubic meter (m^3) of boards.--	1	2
52.	Determine sizes of saw blades in points per inch.----------	1	2
53.	Determine the sizes of drill bits in inches.----------	1	2
54.	Check building lines from a scaled drawing.	1	2

	NEEDED	NOT NEEDED
55. Find the differences in grade level between several points. ----------	1	2
56. Determine floor levels, grade lines, window and door heights, roof slopes from elevation views. ----------	1	2
57. Calculate concrete amounts by the cubic yard.----------	1	2
58. Find the number of blocks for a foundation wall of a certain perimeter. ----------	1	2
59. Find a roof area.----------	1	2

PLEASE ADD ADDITIONAL COMPETENCIES YOU BELIEVE ARE NEEDED

60. ----------

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61. ----------

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62. ----------

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63. ----------

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64. ----------

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65. ----------

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66. ----------

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67. ----------

EXIT MATH COMPETENCIES

FOR

DRAFTING

Directions: Circle the number which indicates whether or not a student needs the competency when exiting your drafting program. Please do not leave any item unanswered.

	NEEDED	NOT NEEDED
1. Add, subtract, multiply on a number line. -	1	2
2. Represent the products of two numbers on a graph. ----------	1	2
3. Find the value of a radius vector graphically. ----------	1	2
4. Represent trigonometric functions by graphing. ----------	1	2
5. Determine x and y intercepts on a graph. --	1	2
6. Solve two simultaneous equations by graphing. ----------	1	2
7. Convert a whole number to a positive power of ten. Example:(46 TO 4.6 X 10 = ?)	1	2
8. Add,subtract,multiply,and divide positive and negative powers of ten.Example: (4 x 10) + (6 x 10) = ?	1	2
9. Square a number. ----------	1	2
10. Find the square root of a number. ---------	1	2
11. Square a monomial. Example: (2ab) = ? -----	1	2
12. Cube a monomial. Example: (3a b) = ? ------	1	2
13. Take the square root of a monomial.(4 = ?)	1	2
14. Find the cube root of a monomial. Example: (8 = ?) ----------	1	2
15. Square a binomial. Example: (a - b = ?) ___	1	2
16. Take the square root of a trinomial. Example:(a + 2ab + b = ?)----------	1	2

	NEEDED	NOT NEEDED
17. Multiply and divide numbers with exponents. Example:(a x a = ?) ----------	1	2
18. Multiply a number with an exponent by an exponent. Example: (a) = ? ----------	1	2
19. Multiply a fraction with an exponent by an exponent. Example: (x / y = ?) -------	1	2
20. Express numbers with negative exponents as numbers with positive exponents. Example: (a b = ?) ----------	1	2
21. Find the values of numbers with fractional Exponents. Example:(16) = ? ----------	1	2
22. Simplity radicals containing fractions. Example:(5/6 = ?)----------	1	2
23. Add and subtract radicals. Example: (2 2 + 2 3 = ?)----------	1	2
24. Group terms in an equation. ----------	1	2
25. Determine signs in a complex equation. ----	1	2
26. Solve equations with one unknown. ---------	1	2
27. Solve equations by transposing. Example: (e + 4 = 12, e = ?) ----------	1	2
28. Solve an equation by canceling a term. Example: (x - y = 2 - x , y = ?) ---------	1	2
29. Chech solutions for equations. ----------	1	2
30. Form equations from observed data. -------	1	2
31. Solve a problem using a formula with knowns and one unknown expressed in the same unit.	1	2
32. Solve a problem involving 2 formulas, 3 or more knowns, and one unknown. --------	1	2
33. Solve a problem involving 3 formulas, 3 or more knowns, and one or more unknowns. ----------	1	2

	NEEDED	NOT NEEDED
34. Solve a quadratic equation. Example:(X - 25 = 0, X = ?)----------	1	2
35. Solve equations with the quadratic formula. Example: (2a + 2a - 6 = 0) -------	1	2
36. Solve quadratic equations by graphing.Example: (x - 10x + 16 = 0).	1	2
37. Factor a simple equation.	1	2
38. Find the prime factors of equations.Example: (3ax + 6ax +3 ay =?).	1	2
39. Find the product with the difference and sum of two equations. Example: (a + b) (a - b) = ? ----------	1	2
40. Factor the sum and difference of 2 cubes. Example: b + c / a - b ----------	1	2
41. Solve simultaneous linear equations by addition and subtraction. ----------	1	2
42. Solve simultaneous linear equations by substitution. ----------	1	2
43. Solve simultaneous equations by comparison. -	1	2
44. Solve fractional form simultaneous equations. Example: (x/4 + y/3 = 7/12).----------	1	2
45. Determine complementary and supplementary angles of a triangle. ----------	1	2
46. Find the arc, sine, cosine and tangent of an angle. ----------	1	2
47. Find functions of angles greater than 90 . -	1	2
48. Find functions of an angle in second, third and fourth quadrants. ----------	1	2
49. Solve a problem involving similar right triangles. ----------	1	2
50. Find trigonometric ratios of angles of right triangles. ----------	1	2
51. Solve for angles, sides and hypotenuse for a right triangle. ----------	1	2

	NEEDED	NOT NEEDED
52. Solve graphically for elements of a right triangle. ----------	1	2
53. Solve word problems related to a right triangle. ----------	1	2
54. Find the least common multiple. Example: 6x y = ? ----------	1	2
55. Reduce a fraction to its lowest term. Example: $\frac{12X\ Y}{24X\ Y\ Z}$ ----------	1	2
56. Change sign of fractions. Example: $\frac{+a}{-b}$ = ? ---	1	2
57. Add, subtract, multiply and divide fractions. Example: $\frac{e\ -\ 4}{\frac{4}{1\ +\ e}}$ $\frac{}{5}$ ----------	1	2
58. Convert a fraction to a decimal. ----------	1	2
59. Express equations in logarithmic form. Example: (10 = 10,000) _____	1	2
60. Find the logarithm of a product. Example: Log of (M X N = ?)_____	1	2
61. Find the logarithm of a quotient. Example: Log of $\frac{M}{N}$ _____	1	2
62. Find the logarithm of a power. Example:(10 = ?)	1	2
63. Find the logarithm of a root. Example:(10 = ?)	1	2
64. Find the logarithm of a number. Example:(140 = ?)	1	2
65. Express equations in exponential form. Example: (LOG 1 = 0) _____	1	2
66. Find the antilog of a number. Example: (.8782 = ?) _____	1	2

	NEEDED	NOT NEEDED
67. Add logarithms.	1	2
68. Subtract logarithms.	1	2
69. Multiply logarithms.	1	2
70. Compute logarithms with negative numbers.	1	2
71. Division by logarithms.	1	2
72. Multiplication and division by logarithms.	1	2
73. Extracting roots by logarithms.	1	2
74. Compute equations using logarithms with fractional exponents. Example: (14.3) = ?	1	2
75. Graph a logarithm funciton. Example :(y=log x)	1	2
76. Solve a logarithmic equation. Example: (log x - log x = 0.3)	1	2
77. Find the correct proportions of selected objects.	1	2
78. Determine dimensions to scale.	1	2

Define the following :

79. Parts of a circle.	1	2
80. Concentric circles.	1	2
81. Eccentric circles.	1	2
82. Right angle.	1	2
83. Acute angle.	1	2
84. Obtuse angle.	1	2
85. Complementary angles.	1	2
86. Supplementary angles.	1	2
87. Calculate the area and circumference of a circle.	1	2

List side and or angle relationships for the following.

88. Equilateral triangle._____ 1 2

89. Isosceles triangle._____ 1 2

90. Scalene triangle._____ 1 2

91. Right triangle._____ 1 2

92. Right triangle in a semi-circle.___ 1 2

List the side and or angle relationships for the following:

93. Square._____ 1 2

94. Rectangle._____ 1 2

95. Rhombus._____ 1 2

96. Rhomboid._____ 1 2

97. Trapezoid._____ 1 2

98. Trapezium._____ 1 2

List the side and or angle relationships for the following:

99. Pentagon._____ 1 2

100. Hexagon._____ 1 2

101. Heptagon._____ 1 2

102. Octagon._____ 1 2

103. Nonagon._____ 1 2

104. Decagon._____ 1 2

105. Dodecagon._____ 1 2

List the side and or angle relationship for the following:

106. Tetrahedron._____ 1 2

107. Hexahedron._____ 1 2

	NEEDED	NOT NEEDED
108. Octahedron.	1	2
109. Dodecahedron.	1	2
110. Icosohedron.	1	2

List side and or angle relationships for the following:

111. Right square.	1	2
112. Oblique triangle.	1	2

List side and or angle relationships for the following:

113. Right triangular prism.	1	2
114. Right rectangular prism.	1	2
115. Right pentagonal prism.	1	2
116. Oblique pentagonal prism.	1	2
117. Oblique hexagonal prism.	1	2

List elements for the following:

118. Right circular cylinder.	1	2
119. Oblique circular cylinder.	1	2

List side and or angle relationships for the following:

120. Right triangular pyramid.	1	2
121. Right square pyramid.	1	2
122. Oblique pentagonal pyramid.	1	2

List elements for the following:

123. Right circular cone.	1	2
124. Oblique circular cone.	1	2
125. Sphere.	1	2
126. Torus.	1	2

	NEEDED	NOT NEEDED
127. Divide lines in equal divisions.	1	2
128. Determine measurements of enlarged and reduced objects.	1	2
129. Determine tolerances and limits of drill holes.	1	2
130. Determine clearance, transition, and interference fits.	1	2
131. Determine dimensions and tolerances of an internal and an external cylindrical surface.	1	2
132. Compute horizontal and vertical spacing of an object.	1	2
133. Construct a bar graph.	1	2
134. Describe information from a line graph.	1	2
135. Construct a circle graph and pie chart.	1	2
136. Compute diametral pitch of a gear.	1	2
137. Compute circulat pitch of a thread.	1	2
138. Compute vertical spacing, given the working space and height of an object.	1	2
139. Com re diametral pitch of a gear.	1	2
140. Compute circular pitch of a gear.	1	2
141. Compute pitch diameter of a gear.	1	2
142. Compute outside diameter of a gear.	1	2
143. Compute root diameter of a gear.	1	2
144. Compute addendum of a gear.	1	2
145. Compute dedendum of a gear.	1	2
146. Calculate whole depth using a formula.	1	2
147. Compute circular thickness of a gear tooth.	1	2
148. Determine metric numbers that represent the SI prefix symbols.	1	2

	NEEDED	NOT NEEDED
149. Determine metric prefix names for prefix symbols. _____	1	2
150. Find the equivalent value in metrics of a value with a prefix symbol. _____	1	2
151. Determine customary lengths for selected metric lengths. _____	1	2
152. Convert units in the metric system. Example: (M to mm). _____	1	2
153. Convert lengths from English to metric. ___	1	2
154. Calculate areas of objects in the metric system. _____	1	2
155. Convert lengths from metric to English. ____	1	2
156. Convert dimensions of objects from English to metric. _____	1	2
157. Convert areas measurements to metric areas.	1	2
158. Compute metric volumes. _____	1	2
159. Convert customary dimensions to metric dimensions and calculate the volume in metric units.	1	2

Find the correct drafting scale ratio in metrics for:

160. Assembly drawings. _____	1	2
161. Detail drawings. _____	1	2
162. Working drawings. _____	1	2
163. Site plans. _____	1	2
164. Surveys. _____	1	2
165. Maps. _____	1	2

PLEASE ADD ADDITIONAL COMPETENCIES YOU BELIEVE ARE NEEDED.

166. _____

167. _____

EXIT MATH COMPETENCIES

FOR

ELECTRICITY AND ELECTRONICS

Directions: Circle the number which indicates whether or not a student needs the competency when exiting your basic electronics program. Please do not leave any item unanswered.

	NEEDED	NOT NEEDED
1. Add, subtract, multiply on a number line. -	1	2
2. Represent the products of two numbers on a graph. ----------	1	2
3. Find the value of a radius vector graphically. ----------	1	2
4. Represent trigometric functions by graphing. ----------	1	2
5. Determine x and y intercepts on a graph. --	1	2
6. Solve two simultaneous equations by graphing. ----------	1	2
7. Convert a whole number to a positive power of ten. Example:(46 = 4.6 X ?)_____	1	2
8. Add, subtract, multiply, and divide positive and negative powers of ten. Example: (4x10)+(6x10) = ?	1	2
9. Square a number. ----------	1	2
10. Find the square root of a number. ---------	1	2
11. Square a monomial. Example: (2ab) = ? ----	1	2
12. Cube a monomial. Example: (3a b) = ? -----	1	2
13. Take the square root of a monomial.(4 = ?)	1	2
14. Find the cube root of a monomial. Example: (-8 = ?) ----------	1	2
15. Square a binomial. Example: (a - b) = ? ---	1	2
16. Take the square root of a trinomial. Example:(a + 2ab + b = ?) ----------	1	2

	NEEDED	NOT NEEDED
17. Multiply and divide numbers with exponents. Example:(a x a) = ? ---------	1	2
18. Multiply a number with an exponent by an exponent. Example: (a) = ? ----------	1	2
19. Multiply a fraction with an exponent by an exponent. Example: (x / y) = ? -------	1	2
20. Express numbers with negative exponents as numbers with positive exponents. Example: (a b) = ? ----------	1	2
21. Find the values of numbers with fractional exponents. Example: (16) = ? ----------	1	2
22. Simplify radicals containing fractions. Example:(5/6) = ? ----------	1	2
23. Add and subtract radicals. Example: (2 2 + 2 3) = ? ----------	1	2
24. Group terms in an equation. ----------	1	2
25. Determine signs in a complex equation. ----	1	2
26. Solve equations with one unknown. ---------	1	2
27. Solve equations by transposing. Example: (e + 4) = 12, e = ? ----------	1	2
28. Solve an equation by canceling a term. Example: (x - y = 2 - x), y = ? ----------	1	2
29. Check solutions for equations. ----------	1	2
30. Form equations from observed data. -------	1	2
31. Solve a problem using a formula with knowns and one unknown expressed in the same unit. Example: a problem about Ohm's law. ----------	1	2
32. Solve a problem involving 2 formulas, 3 or more knowns, and one unknown. --------	1	2
33. Solve a problem involving 3 formulas, 3 or more knowns, and one or more unknown. ----------	1	2

	NEEDED	NOT NEEDED
34. Solve a quadradic equation. Example:(x - 25 = 0) x = ? ----------	1	2
35. Solve equations with the quadradic formula. (Example: 2a + 2a - 6 = 0) ------	1	2
36. Solve quadradic equations by graphing.Example: (x - 10x + 16 = 0) = ?	1	2
37. Factor a simple equation.	1	2
38. Find the prime factors of equations.Example: (3ax + 6ax +3 ay) = ?	1	2
39. Find the product with the difference and sum of two equations. Example: (a + b) (a - b) = ? ----------	1	2
40. Factor the sum and difference of 2 cubes. Example: b + c = ? a - b = ? ----------	1	2
41. Solve simultaneous linear equations by addition and subtraction. ----------	1	2
42. Solve simultaneous linear equations by substitution. ----------	1	2
43. Solve simultaneous equations by comparison. -	1	2
44. Solve fractional form simultaneous equations. Example: (x/4 + y/3 = 7/12).----------	1	2
45. Determine complimentary and supplementary angles of a triangle. ----------	1	2
46. Find the arc, sine, cosine and tangent of an angle. ----------	1	2
47. Find functions of angles greater than 90 . -	1	2
48. Find functions of an angle in second, third and fourth quadrants. ----------	1	2
49. Solve a problem involving similar right triangles. ----------	1	2
50. Find trigometric ratios of angles of right triangles. ----------	1	2
51. Solve for angles, sides and hypotenuse for a right triangle. ----------	1	2

	NEEDED	NOT NEEDED
52. Solve graphically for elements of a right triangle. ----------	1	2
53. Solve word problems related to a right triangle. ----------	1	2
54. Find the least common multiple. Example: (6 x y) = ? ----------	1	2
55. Reduce a fraction to its lowest term. Example: $\frac{12x\ y}{24x\ y\ z} = ?$ ----------	1	2
56. Change sign of fractions. Example: $\frac{+a}{-b} = ?$ ---	1	2
57. Add, subtract, multiply and divide fractions. Example: $\frac{\frac{e}{4} - 4}{1 + e} = ?$ ----------	1	2
58. Convert a fraction to a decimal. ----------	1	2
59. Set up equations from theory. Example: Kirchoff's Law._____	1	2
60. Express equations in logarithmic form.Example: (10 =10,000)._____	1	2
61. Find the logarithm of a product. Example: Log of (M X N) =? _____	1	2
62. Find the logarithm of a quotient. Example:(Log $a = \frac{m}{n}$ _____	1	2
63. Find the logarithm of a power. Example:(10) = ?	1	2
64. Find the logarithm of a root. Example:(10) = ?	1	2
65. Find the logarithm of a number. Example:(140)= ?	1	2
66. Express equations in exponential form. Example: (Log 1 = 0) _____	1	2
67. Find the antilog of a number. Example:(.8782) = ?	1	2
68. Add logarithms. _____	1	2

		NEEDED	NOT NEEDED
69.	Subtract logarithms.	1	2
70.	Multiply logarithms.	1	2
71.	Compute logarithms with negative numbers.	1	2
72.	Division by logarithms.	1	2
73.	Multiplication and division by logarithms.	1	2
74.	Extracting roots by logarithms.	1	2
75.	Compute equations using logarithms with fractional exponents. Example: (14.3) = ?	1	2
76.	Graph a logarithm function. Example:(y=log x)	1	2
77.	Solve a logarithmic equation. Example: (log x - log x = 0.3)	1	2
78.	Solve electronic problems using logarithms. Example: q = CE (1 - E)	1	2
79.	Express gain or loss ot apparatus in decibels, (logarithms). Example: 20 = 10 log p	1	2
	6		
80.	Express gain or loss of quantities in decibels, (logarithms).	1	2
81.	Find the inductance ot a line using logarithms.	1	2
82.	Find the impedance of a line using logarithms.	1	2
83.	Find the capacitance of a line using logarithms.	1	2
84.	Graph the equation (y = sin x).	1	2
85.	Graph the cosine curve. Example: (y = cos x).	1	2
86.	In equations ot periodic curves, specify trequency.	1	2
87.	In equations ot periodic curves, specity angle of velocity.	1	2
88.	In equations of periodic curves, specify the amplitude.	1	2
89.	In equations of periodic curves, specigy period.	1	2

	NEEDED	NOT NEEDED
90. In equations of periodic curves, specity angle of lead or lag.	1	2
91. Find the magnitude and direction of vectors.	1	2
92. Find the horizontal and vertical components of vectors.	1	2
93. Find the resultant forces of vectors.	1	2
94. Use vector diagrams to find instantaneous values in an AC circuit.	1	2
95. Determine angles in a vector diagram ot an AC circuit.	1	2
96. Find the angular velocity of an AC circuit.	1	2
97. Write equations for voltage and current using an AC circuit.	1	2
98. Draw vector diagrams of circuits, and construct vectors for AC circuits.	1	2
99. Determine angles in a vector diagram and plot imaginary numbers on a vector diagram.	1	2
100. Express AC circuit parameters in polar form.	1	2
101. Convert AC circuit parameters from rectangular to polar form and vice versa.	1	2
102. Solve problems using parameters expressed in rectangular form.	1	2
103. Solve problems using parameters expressed in polar form.	1	2
104. Add vectors in rectangular form.	1	2
105. Subtract vectors in rectangular form.	1	2
106. Multiply vectors in rectangular form.	1	2
107. Divide vectors in rectangular form.	1	2
108. Multiply polar vectors.	1	2
109. Divide polar vectors.	1	2
110. Express numbers in the binary number system.	1	2

	NEEDED	NOT NEEDED
111. Construct and analyze truth tables.	1	2
112. Develop a Boolean equation from a logic diagram.	1	2
113. Use the sum of products method to solve a Boolean equation.	1	2
114. Develop a sum - of - products equation from a truth table.	1	2
115. simplify a Boolean equation.	1	2
116. Convert a truth table into a Karnough map.	1	2
117. Draw a three and four variable Karnough map from a truth table.	1	2
118. Simplify a Karnough map by using octets, quads, or pairs.	1	2
119. Use the product of sums method to simplify a a truth table.	1	2
120. Convert a truth table to an equation.	1	2
121. Simplify a product of sums equation.	1	2
122. Use multiplexer logic.	1	2
123. Find BCD equivalents of decimal numbers.	1	2
124. Convert binary numbers to decimal equivalents.	1	2
125. Convert octal numbers to decimal equivalents.	1	2
126. Find the decimal equivalent of an octal number.	1	2
127. Convert hexadecimal numbers to binary numbers.	1	2
128. Express a decimal number in excess - 3 code.	1	2
129. Express an excess - 3 number as a decimal equivalent.	1	2
130. Convert gray numbers to a decimal equivalent.	1	2
131. Give the sum of numbers in base 8 or 16.	1	2
132. Give the sum of binary numbers.	1	2
133. Add whole numbers in base 10 using 16 bit numbers.	1	2

	NEEDED	NOT NEEDED
134. Subtract binary numbers.	1	2
135. Subtract whole numbers in the base ten system.	1	2
136. Determine overflow of problems with 8 bit unsigned arithmetic.	1	2
137. Express positive or negative whole numbers in 8 bit sign magnitude form.	1	2
138. Convert sign magnitude numbers into decimal equivalents.	1	2
139. Express the complement of numbers in hexadecimal notation.	1	2
140. Express the 2's complement of binary numbers.	1	2
141. Convert positive or negative whole numbers to 2'S complement representation.	1	2
142. Show the 8 bit addition and subtraction of decimal numbers in 2's complement representation.	1	2

PLEASE ADD COMPETENCIES YOU BELIEVE ARE NECESSARY TO EXIT FROM YOUR PROGRAM.

143. _____

144. _____

145. _____

146. _____

147. _____

148. _____

149. _____

150 _____

EXIT MATH COMPETENCIES

FOR

GRAPHIC ARTS

Directions : Circle the number which indicates whether or not a student needs the competency when exiting your basic graphic arts program. Please do not leave any item unanswered.

	NEEDED	NOT NEEDED
1. Find the area of a square, rectangle. ---	1	2
2. Convert from inches, points, picas to picas, inches, points. ----------	1	2
3. Interpolate measurements in inches, points, picas. ----------	1	2
4. Determine metric numbers that represent the SI prefix symbols. ----------	1	2
5. Determine metric prefix names for prefix symbols. ----------	1	2
6. Find the equivalent value in metrics of a value with a prefix symbol. ----------	1	2
7. Determine customary lengths for selected metric lengths. ----------	1	2
8. Convert lengths from English to metric.	1	2
9. Convert dimensions of objects from English to metric. ----------	1	2
10. Convert area measurements to metric areas.	1	2
11. Find the square inches of a rectangle. -	1	2
12. Convert fractions to decimals. --------	1	2
13. Convert decimals to fractions. --------	1	2
14. Measure accuractely from the layout the position of words or lines. ----------	1	2

		NEEDED	NOT NEEDED
15.	Determine top and side margins of pages using percentages. ----------	1	2
16.	Solve problems to determine size of vertical margins of paper. ----------	1	2
17.	Find the average length of a line of print in a page. ----------	1	2
18.	Find the number of characters that will fit into a selected line length. ------	1	2
19.	Find the column depth by the point size.	1	2
20.	Determine percent reductions of original copies. ----------	1	2
21.	Read and interpolate numbers from a proportional scale. ----------	1	2
22.	Determine enlargement size and reduced size of photographs. ----------	1	2
23.	Give inlargement and reduction specifications of photos in percentages. -----	1	2
24.	Determine the relationship between percentage of copy reduction and number of points in the printed product. -----	1	2
25.	Read and interpolate values on a "Density of Copy" scale. ----------	1	2
26.	Determine appropriate screen angles when printing Duotone prints. ----------	1	2
27.	Determine the paper position on the tympan of a platen press. ----------	1	2
28.	When cutting paper, calculate the number of press sheets that can be obtained from the stock sheet. ----------	1	2
29.	When cutting paper, figure the number of stock sheets needed. ----------	1	2
30.	Find the 1,000 sheet weights of special size sheets. ----------	1	2
31.	Find the cost of paper in different quantities. ----------	1	2

EXIT MATH COMPETENCIES

FOR

MACHINE SHOP

Directions: Circle the number which indicates whether or not a student needs the competency when exiting your basic machine shop program. Please do not leave any item unanswered.

		NEEDED	NOT NEEDED
1.	Add, subtract, multiply on a number line. -	1	2
2.	Represent the products of two numbers on a graph.----------	1	2
3.	Find the value of a radius vector graphically. ----------	1	2
4.	Represent trigonometric functions by graphing. ----------	1	2
5.	Determine x and y intercepts on a graph. --	1	2
6.	Solve two simultaneous equations by graphing. ----------	1	2
7.	Convert a whole number to a positive power of ten. Example:(46 = 4.6 X ?)_____	1	2
8.	Add,subtract,multiply,and divide positive and negative powers of ten.Example: (4x10)+(6x10) = ?	1	2
9.	Square a number. ----------	1	2
10.	Find the square root of a number. ---------	1	2
11.	Square a monomial. Example: (2ab) = ? ----	1	2
12.	Cube a monomial. Example: (3a b) = ? -----	1	2
13.	Take the square root of a monomial.(4 = ?)	1	2
14.	Find the cube root of a monomial. Example: (-8 = ?) ----------	1	2
15.	Square a binomial. Example: (a - b) = ? ---	1	2
16.	Take the square root of a trinomial. Example:(a + 2ab + b = ?) ----------	1	2

	NEEDED	NOT NEEDED
17. Multiply and divide numbers with exponents. Example:(a x a) = ? ---------	1	2
18. Multiply a number with an exponent by an exponent. Example: (a) = ? ----------	1	2
19. Multiply a fraction with an exponent by an exponent. Example: (x / y) = ? -------	1	2
20. Express numbers with negative exponents as numbers with positive exponents. Example: (a b) = ? ----------	1	2
21. Find the values of numbers with fractional exponents. Example: (16) = ? ----------	1	2
22. Simplify radicals containing fractions. Example:(5/6) = ? ----------	1	2
23. Add and subtract radicals. Example: (2 2 + 2 3) = ? ----------	1	2
24. Group terms in an equation. ----------	1	2
25. Determine signs in a complex equation. ----	1	2
26. Solve equations with one unknown. ---------	1	2
27. Solve equations by transposing. Example: (e + 4) = 12, e = ? ----------	1	2
28. Solve an equation by canceling a term. Example: (x - y = 2 - x), y = ? ---------	1	2
29. Check solutions for equations. ----------	1	2
30. Form equations from observed data. -------	1	2
31. Solve a problem using a formula with knowns and one unknown expressed in the same unit. ----------	1	2
32. Solve a problem involving 2 formulas, 3 or more knowns, and one unknown. --------	1	2
33. Solve a problem involving 3 formulas, 3 or more knowns, and one or more unknowns. ----------	1	2

	NEEDED	NOT NEEDED
34. Solve a quadratic equation. Example:(x - 25 = 0) x = ? ----------	1	2
35. Solve equations with the quadratic formula. (Example: 2a + 2a - 6 = 0) ------	1	2
36. Solve quadratic equations by graphing.Example: (x - 10x + 16 = 0) = ?	1	2
37. Factor a simple equation.	1	2
38. Find the prime factors of equations.Example: (3ax + 6ax +3 ay) = ?	1	2
39. Find the product with the difference and sum of two equations. Example: (a + b) (a - b) = ? ----------	1	2
40. Factor the sum and difference of 2 cubes. Example: b + c = ? a - b = ? ----------	1	2
41. Solve simultaneous linear equations by addition and subtraction. ----------	1	2
42. Solve simultaneous linear equations by substitution. ----------	1	2
43. Solve simultaneous equations by comparison. -	1	2
44. Solve fractional form simultaneous equations. Example: (x/4 + y/3 = 7/12).----------	1	2
45. Determine complementary and supplementary angles of a triangle. ----------	1	2
46. Find the arc, sine, cosine and tangent of an angle. ----------	1	2
47. Find functions of angles greater than 90 . -	1	2
48. Find functions of an angle in second, third and fourth quadrants. ----------	1	2
49. Solve a problem involving similar right triangles. ----------	1	2
50. Find trigonometric ratios of angles of right triangles. ----------	1	2
51. Solve for angles, sides and hypotenuse for a right triangle. ----------	1	2

	NEEDED	NOT NEEDED
52. Solve graphically for elements of a right triangle. ----------	1	2
53. Solve word problems related to a right triangle. ----------	1	2
54. Find the least common multiple. Example: (6 x y) = ? ----------	1	2
55. Reduce a fraction to its lowest term. Example: $\frac{12x\ y}{24x\ y\ z} = ?$ ----------	1	2
56. Change sign of fractions. Example: $\frac{+a}{-b} = ?$ ---	1	2
57. Add, subtract, multiply and divide fractions. Example: $\frac{e^{4} - 4}{1 + e^{5}} = ?$ ----------	1	2
58. Convert a fraction to a decimal. ----------	1	2
59. Set up equations from theory. ----------	1	2
60. Express equations in logarithmic form.Example: (10 =10,000). _____	1	2
61. Find the logarithm of a product. Example: Log OF (M X N) =? _____	1	2
62. Find the logarithm of a quitient. Example:(Log $a = \frac{m}{n}$ _____	1	2
63. Find the logarithm of a power. Example:(10) = ?	1	2
64. Find the logarithm of a root. Example:(10) = ?	1	2
65. Find the logarithm of a number. Example:(140)= ?	1	2
66. Express equations in exponential form. Example: (Log 1 = 0) _____	1	2
67. Find the antilog of a number. Example:(.8782) = ?	1	2
68. Add logarithms. _____	1	2

		NEEDED	NOT NEEDED
69.	Subtract logarithms.	1	2
70.	Multiply logarithms.	1	2
71.	Compute logarithms with negative numbers.	1	2
72.	Division by logarithms.	1	2
73.	Multiplication and division by logarithms.	1	2
74.	Extracting roots by logarithms.	1	2
75.	Compute equations using logarithms with fractional exponents. Example: (14.3) = ?	1	2
76.	Graph a logarithm function. Example:(y=log x)	1	2
77.	Solve a logarithmic equation. Example: (log x - log x = 0.3)	1	2
78.	Convert from English units to metric units and vice versa.	1	2
79.	Determine tolerance for a measurement.	1	2
80.	Find the circumference for a circle.	1	2
81.	Find the perimeter of any polygon.	1	2
82.	Find the area of a circle.	1	2
83.	Find the pitch of a screw.	1	2
84.	Find the cutting speed, given the revolutions of the lathe per minute, and the diameter.	1	2
85.	Solve problems using percentages.	1	2
86.	Read a micrometer.	1	2
87.	Read a vernier caliper.	1	2
88.	Read a vernier protractor.	1	2
89.	Subtract with degrees, minutes, and seconds.	1	2
90.	Find decimal equivalents of minutes and seconds.	1	2
91.	Find minute and second equivalents of decimals.	1	2

	NEEDED	NOT NEEDED
92. Determine sizes of angles on drawings.	1	2
93. Find the area of a circle, triangle, square, parallelogram and rectangle.	1	2
94. Find the diagonal of a square.	1	2
95. Find the distance across the flats of corners in a hexagon.	1	2
96. Use a table of natural functions to find a function of an angle.	1	2
97. Interpolate to find values of angle functions for minutes.	1	2
98. Use the law of sines to solve an oblique triangle.	1	2
99. Use the law of cosines to solve an oblique triangle.	1	2
100. Determine the amount of taper.	1	2
101. Determine the amount of offset needed to produce a given taper.	1	2
102. Convert taper measurements to angle measurements.	1	2
103. Determine the amount of error in a given taper.	1	2
104. Use a general speed formula for two gears in mesh to solve problems.	1	2
105. Solve problems involving simple and compound gear trains.	1	2
106. Solve problems involving worm gearing.	1	2
107. Find the rpm of a tool, knowing the cutting speed and diameter.	1	2
108. Calculate drill speeds.	1	2
109. Find the rate of speed for lathe tools.	1	2
110. Determine a cutting time for lathe and milling operations.	1	2
111. Find the pitch of a thread.	1	2
112. Measure a screw thread.	1	2

	NEEDED	NOT NEEDED
113. Determine outside diameters and tap drill sizes for machine screws.	1	2
114. Find the outside diameter of a gear, knowing the number of teeth and diametrical pitch.	1	2
115. Find the center to center distance for two meshing spur gears.	1	2
116. Design a gear train.	1	2
117. Use continued fractions to convert speed ratio's into gear combinations.	1	2
118. Convert metric module to diametrical pitch.	1	2
119. Determine the number of turns on a dividing head for indexing.	1	2
120. Index for degrees, minutes, and seconds.	1	2

PLEASE ADD COMPETENCIES YOU BELIEVE ARE NECESSARY TO EXIT FROM YOUR PROGRAM ON THE NEXT PAGE.

121. _____

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122. _____

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123. _____

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124. _____

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EXIT MATH COMPETENCIES

FOR

MASONRY

Directions : Circle the number which indicates whether or not a student needs the competency when exiting your basic masonry program. Please do not leave any item unanswered.

		NEEDED	NOT NEEDED
1.	Add, subtract, multiply and divide whole numbers. ----------	1	2
2.	Add, subtract, multiply and divide decimals. ----------	1	2
3.	Convert a fraction to a decimal. -------	1	2
4.	Convert decimals to fractions. ---------	1	2
5.	Add, subtract, multiply, and divide fractions. ----------	1	2
6.	Determine metric numbers that represent the SI prefix symbols. ----------	1	2
7.	Determine metric prefix names for prefix symbols. ----------	1	2
8.	Find the equivalent value in metrics of a value with a prefix symbol. ----------	1	2
9.	Determine customary lengths for selected metric lengths. ----------	1	2
10.	Convert units in the metric system. Example : M to mm. ----------	1	2
11.	Convert lengths from metric to English.	1	2
12.	Calculate the areas of objects from English to metric. ----------	1	2
13.	Convert lengths from metric to English.	1	2

		NEEDED	NOT NEEDED
14.	Convert dimensions of objects from English to metric. ----------	1	2
15.	Convert areas measurements to metric areas. ----------	1	2
16.	Compute metric volumes. ----------	1	2
17.	Determine complementary and supplementary angles of a triangle. ----------	1	2
18.	Solve a problem involving similar right triangles. ----------	1	2
19.	Solve word problems related to a right triangle. ----------	1	2
20.	Use percentages to solve problems. -----	1	2
21.	Calculate the amount of interest paid on a loan. ----------	1	2
22.	Determine the length of a line. --------	1	2
23.	Calculate the circumference of a circle.	1	2
24.	Calculate the area of a parallelogram, trapezoid, triangle, regular polygon, circle, and ellipse. ----------	1	2
25.	Calculate the volume of a rectangular solid, prism, cylinder, cone, pyramid, and sphere. ----------	1	2
26.	Estimate the amount of brick masonry needed for a wall unit. ----------	1	2
27.	Estimate the amount of damp sand needed for mortar. ----------	1	2
28.	Determine sizes of angles on drawings. -	1	2
29.	Find the diagonal of a square. --------	1	2
30.	Use an archetects scale to check the dimensions on a scaled drawing. -------	1	2
31.	Figure the normal dead load. ----------	1	2

	NEEDED	NOT NEEDED
32. Figure the live load. ----------	1	2
33. Find the tolerance for window clearance.	1	2
34. Determine the amount of heat lost through certain materials. ----------	1	2
35. Calculate the number and size of risers and treads for a given stair run. -----	1	2
36. Calculate the area of a flue. ---------	1	2
37. Check building lines from a scaled drawing.	1	2
38. Find the differences in grade level between several points. ----------	1	2
39. Determine floor levels, grade lines, window and door heights, roof slopes from elevation views. ----------	1	2
40. Calculate concrete amounts by the cubic yard.----------	1	2
41. Find the number of blocks for a foundation wall of a certain perimeter. ----------	1	2
42. Determine the number of ties needed per square foot of wall. ----------	1	2
43. Calculate the diameter and radius of a circle. ----------	1	2
44. Calculate the width of footing for an 8" concrete block foundation wall in inches.	1	2
45. Calculate the proper slope for a walk or patio. ----------	1	2

PLEASE ADD ADDITIONAL COMPETENCIES YOU BELIEVE ARE NEEDED

46. ----------

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47. ----------

EXIT MATH COMPETENCIES

FOR

WELDING

Directions : Circle the number which indicates whether or not a student needs the competency when exiting your basic welding program. Please do not leave any item unanswered.

	NEEDED	NOT NEEDED
1. Determine metric numbers that represent the SI prefix symbols. ----------	1	2
2. Determine metric prefix names for prefix symbols. ----------	1	2
3. Find the equivalent value in metrics of a value with a prefix symbol. ----------	1	2
4. Determine customary lengths for selected metric lengths. ----------	1	2
5. Convert lengths from English to metric.	1	2
6. Convert dimensions of objects from English to metric. ----------	1	2
7. Convert area measurements to metric areas.	1	2
8. Find the area (in square inches) of a rectangle. ----------	1	2
9. Convert fractions to decimals. --------	1	2
10. Convert decimals to fractions. --------	1	2
11. Add and subtract using fractions. ------	1	2
12. Find the diameter of a circle. ---------	1	2
13. Find the radius of a circle. ----------	1	2
14. Solve problems using percentages. ------	1	2
15. Determine the sizes of angles on drawings.	1	2

		NEEDED	NOT NEEDED
16.	Find the diagonal of a square. ----------	1	2
17.	Find the area of a circle, rectangle, square, and triangle. ----------	1	2
18.	Convert temperatures in Farenheit to Celsius.----------	1	2
19.	Determine the size of a groove weld. ---	1	2
20.	Determine the pitch dimension of a weld.	1	2
21.	Determine the groove angle for a weld.---	1	2
22.	Determine the effective throat size of a weld. ----------	1	2
23.	Determine the size of a fillet weld. ----	1	2
24.	Determine the length dimension of a weld.	1	2
25.	Determine the length, width, and angle of countersink for a slot weld from the assembly drawing. ----------	1	2
26.	Determine the maximum working guage pressure for acetylene gas. ----------	1	2
27.	Calculate the bevel angle on a weld. -----	1	2
28.	Calculate the root opening for a weld.----	1	2
29.	Determine the clearance between two metals to be soldered. ----------	1	2
30.	Calculate the rated load voltage for class I and II arc welding machines. ----------	1	2
31.	Calculate the electrical power input requirements for class I and II transformer arc welders. ----------	1	2
32.	Read voltmeter and ammeters. ----------	1	2
33.	Determine the argon glow rate in ft /hr and L/min for welding various materials and joints. ----------	1	2

	NEEDED	NOT NEEDED
34. Calculate the percent heat setting to the current range. ----------	1	2
35. Calculate the duty cycle of resistance welding transformers. ----------	1	2
36. Determine the velocity (in ft./sec, m/sec) of different coating materials used in the thermal spray process. ----------	1	2
37. Determine the pressure in a tank or cylinder given the outside temperature. --	1	2

PLEASE ADD ADDITIONAL COMPETENCIES YOU BELIEVE ARE NEEDED.

38. ----------

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40. ----------

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41. ----------

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43. ----------

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44. ----------

Appendix 2

Tabulations of Survey Response

Item Analysis of Exit Math Competencies for Air Conditioning (N = 12)

Item No.	Needed	Not Needed	Item No.	Needed	Not Needed	Item No.	Needed	Not Needed
1.	10	2	27.	4	8	53.	5	7
2.	4	8	28.	4	8	54.	4	8
3.	2	10	29.	11	1	55.	11	1
4.	1	11	30.	5	7	56.	5	7
5.	1	11	31.	5	7	57.	10	2
6.	1	11	32.	2	10	58.	6	6
7.	5	7	33.	2	10	59.	11	1
8.	3	9	34.	1	11	60.	6	6
9.	3	9	35.	5	7	61.	9	3
10.	2	10	36.	0	12	62.	8	4
11.	6	6	37.	3	9	63.	7	5
12.	3	9	38.	1	11	64.	12	0
13.	2	10	39.	1	11	65.	12	0
14.	2	10	40.	1	11	66.	4	8
15.	1	11	41.	0	12	67.	9	3
16.	1	11	42.	5	7	68.	9	3
17.	0	12	43.	9	3	69.	7	5
18.	2	10	44.	9	3	70.	9	3
19.	3	9	45.	5	7	71.	5	7
20.	2	10	46.	6	6	72.	9	3
21.	2	10	47.	5	7	73.	10	2
22.	2	10	48.	6	6	74.	7	5
23.	0	12	49.	7	5	75.	9	3
24.	7	5	50.	6	6	76.	10	2
25.	5	7	51.	5	7	77.	11	1
26.	2	10	52.	5	7			

Item Analysis of Exit Math Competencies for Auto Body (N = 11)

Item No.	Needed	Not Needed	Item No.	Needed	Not Needed	Item No.	Needed	Not Needed
1.	11	0	12.	9	2	23.	5	6
2.	5	6	13.	5	6	24.	10	1
3.	7	4	14.	11	0	25.	10	1
4.	5	6	15.	11	0	26.	10	1
5.	6	5	16.	11	0	27.	9	2
6.	8	3	17.	9	2	28.	11	0
7.	7	4	18.	6	5	29.	11	0
8.	6	5	19.	5	6	30.	5	6
9.	7	4	20.	9	2	31.	8	3
10.	8	3	21.	9	2	32.	11	0
11.	8	3	22.	9	2			

Item Analysis of Exit Math Competencies for Auto Mechanics (N = 13)

Item No.	Needed	Not Needed	Item No.	Needed	Not Needed	Item No.	Needed	Not Needed
1.	13	0	16.	13	0	31.	7	6
2.	13	0	17.	13	0	32.	7	6
3.	10	3	18.	13	0	33.	7	6
4.	10	3	19.	13	0	34.	6	7
5.	10	3	20.	12	1	35.	7	6
6.	13	0	21.	13	0	36.	7	6
7.	13	0	22.	11	2	37.	7	6
8.	13	0	23.	13	0	38.	7	6
9.	12	1	24.	11	2	39.	13	0
10.	12	1	25.	11	2	40.	13	0
11.	11	2	26.	7	6	41.	6	7
12.	13	0	27.	8	5	42.	13	0
13.	8	5	28.	11	2	43.	13	0
14.	11	2	29.	12	1			
15.	7	6	30.	7	6			

Item Analysis of Exit Math Competencies for Carpentry (N = 11)

Item No.	Needed	Not Needed	Item No.	Needed	Not Needed	Item No.	Needed	Not Needed
1.	11	0	21.	11	0	41.	11	0
2.	10	1	22.	11	0	42.	11	0
3.	11	0	23.	11	0	43.	10	1
4.	10	1	24.	7	4	44.	11	0
5.	11	0	25.	5	6	45.	11	0
6.	9	2	26.	5	6	46.	5	6
7.	1	10	27.	11	0	47.	11	0
8.	1	10	28.	11	0	48.	11	0
9.	1	10	29.	11	0	49.	11	0
10.	1	10	30.	4	7	50.	6	5
11.	3	8	31.	10	1	51.	2	9
12.	3	8	32.	11	0	52.	11	0
13.	1	10	33.	10	1	53.	11	0
14.	1	10	34.	10	1	54.	11	0
15.	1	10	35.	10	1	55.	11	0
16.	1	10	36.	10	1	56.	11	0
17.	2	9	37.	11	0	57.	11	0
18.	11	0	38.	11	0	58.	11	0
19.	11	0	39.	11	0	59.	11	0
20.	11	0	40.	11	0			

Item Analysis of Exit Math Competencies for Drafting (N = 12)

Item No.	Needed	Not Needed	Item No.	Needed	Not Needed	Item No.	Needed	Not Needed
1.	9	3	46.	12	0	91.	12	0
2.	10	2	47.	10	2	92.	12	0
3.	10	2	48.	11	1	93.	12	0
4.	8	4	49.	12	0	94.	12	0
5.	11	1	50.	10	2	95.	11	1
6.	6	6	51.	12	0	96.	11	1
7.	9	3	52.	8	4	97.	10	2
8.	7	5	53.	12	0	98.	9	3
9.	11	1	54.	5	7	99.	12	0
10.	10	2	55.	9	3	100.	12	0
11.	8	4	56.	7	5	101.	9	3
12.	8	4	57.	9	3	102.	12	0
13.	7	5	58.	12	0	103.	7	5
14.	7	5	59.	5	7	104.	7	5
15.	7	5	60.	3	9	105.	7	5
16.	7	5	61.	3	9	106.	5	7
17.	10	2	62.	2	10	107.	6	6
18.	8	4	63.	2	10	108.	5	7
19.	8	4	64.	2	10	109.	5	7
20.	8	4	65.	2	10	110.	6	6
21.	7	5	66.	2	10	111.	10	2
22.	7	5	67.	2	10	112.	11	1
23.	7	5	68.	2	10	113.	6	6
24.	11	1	69.	2	10	114.	6	6
25.	8	4	70.	2	10	115.	6	6
26.	11	1	71.	2	10	116.	6	6
27.	11	1	72.	2	10	117.	6	6
28.	11	1	73.	2	10	118.	9	3
29.	11	1	74.	2	10	119.	8	4
30.	9	3	75.	2	10	120.	7	5
31.	11	1	76.	2	10	121.	7	5
32.	9	3	77.	12	0	122.	6	6
33.	6	6	78.	12	0	123.	8	4
34.	8	4	79.	12	0	124.	8	4
35.	7	5	80.	12	0	125.	8	4
36.	5	7	81.	12	0	126.	6	6
37.	8	4	82.	12	0	127.	12	0
38.	6	6	83.	12	0	128.	12	0
39.	8	4	84.	12	0	129.	12	0
40.	6	6	85.	12	0	130.	12	0
41.	7	5	86.	12	0	131.	12	0
42.	7	5	87.	12	0	132.	12	0
43.	7	5	88.	12	0	133.	11	1
44.	7	5	89.	12	0	134.	11	1
45.	12	0	90.	12	0	135.	11	1

Item Analysis of Exit Math Competencies for Drafting (N = 12) (continued)

Item No.	Needed	Not Needed	Item No.	Needed	Not Needed	Item No.	Needed	Not Needed
136.	10	2	146.	11	1	156.	11	1
137.	10	2	147.	12	0	157.	11	1
138.	12	0	148.	11	1	158.	12	0
139.	12	0	149.	12	0	159.	11	1
140.	12	0	150.	11	0	160.	12	0
141.	12	0	151.	11	1	161.	12	0
142.	12	0	152.	12	0	162.	12	0
143.	12	0	153.	11	1	163.	11	1
144.	12	0	154.	12	0	164.	10	2
145.	12	0	155.	11	1	165.	10	2

Item Analysis of Exit Math Competencies for Electricity (N = 12)

Item No.	Needed	Not Needed	Item No.	Needed	Not Needed	Item No.	Needed	Not Needed
1.	11	1	29.	10	2	57.	6	6
2.	8	4	30.	10	2	58.	12	0
3.	8	4	31.	12	0	59.	9	3
4.	4	8	32.	8	4	60.	4	8
5.	8	4	33.	7	5	61.	1	11
6.	5	7	34.	7	5	62.	1	11
7.	10	2	35.	5	7	63.	4	8
8.	8	4	36.	4	8	64.	3	9
9.	12	0	37.	10	2	65.	4	8
10.	12	0	38.	5	7	66.	4	8
11.	2	10	39.	5	7	67.	1	11
12.	2	10	40.	4	8	68.	2	10
13.	10	2	41.	3	9	69.	2	10
14.	3	9	42.	3	9	70.	2	10
15.	5	7	43.	4	8	71.	1	11
16.	4	8	44.	4	8	72.	2	10
17.	8	4	45.	9	3	73.	2	10
18.	7	5	46.	10	2	74.	1	11
19.	3	9	47.	9	3	75.	2	10
20.	7	5	48.	7	5	76.	1	11
21.	4	8	49.	9	3	77.	1	11
22.	5	7	50.	8	4	78.	1	11
23.	6	6	51.	10	2	79.	1	11
24.	8	4	52.	7	5	80.	1	11
25.	3	9	53.	9	3	81.	3	9
26.	11	1	54.	4	8	82.	3	9
27.	11	1	55.	5	7	83.	3	9
28.	8	4	56.	6	6	84.	4	8

Item Analysis of Exit Math Competencies for Electricity (continued)

Item No.	Needed	Not Needed	Item No.	Needed	Not Needed	Item No.	Needed	Not Needed
85.	4	8	104.	6	6	123.	4	8
86.	7	5	105.	6	6	124.	6	6
87.	4	8	106.	5	7	125.	5	7
88.	7	5	107.	5	7	126.	5	7
89.	6	6	108.	3	9	127.	7	5
90.	6	6	109.	3	9	128.	4	8
91.	10	2	110.	9	3	129.	4	8
92.	9	3	111.	8	4	130.	2	10
93.	9	3	112.	7	5	131.	5	7
94.	8	4	113.	4	8	132.	7	5
95.	8	4	114.	6	6	133.	3	9
96.	6	6	115.	6	6	134.	5	7
97.	11	1	116.	1	11	135.	7	5
98.	9	3	117.	1	11	136.	2	10
99.	7	5	118.	1	11	137.	1	11
100.	5	7	119.	4	8	138.	2	10
101.	3	9	120.	6	6	139.	3	9
102.	4	8	121.	5	7	140.	4	8
103.	4	8	122.	3	9	141.	2	10
						142.	1	11

Item Analysis of Exit Math Competencies for Electronics (N = 14)

Item No.	Needed	Not Needed	Item No.	Needed	Not Needed	Item No.	Needed	Not Needed
1.	14	0	21.	11	3	41.	13	1
2.	14	0	22.	10	4	42.	13	1
3.	14	0	23.	8	6	43.	13	1
4.	13	1	24.	14	0	44.	11	3
5.	13	1	25.	14	0	45.	13	1
6.	11	3	26.	14	0	46.	14	0
7.	14	0	27.	14	0	47.	11	3
8.	14	0	28.	14	0	48.	11	3
9.	14	0	29.	14	0	49.	13	1
10.	12	2	30.	14	0	50.	14	0
11.	10	4	31.	14	0	51.	14	0
12.	9	5	32.	13	1	52.	13	1
13.	11	3	33.	11	3	53.	12	2
14.	9	5	34.	11	3	54.	10	4
15.	12	2	35.	11	3	55.	10	4
16.	9	5	36.	9	5	56.	10	4
17.	14	0	37.	14	0	57.	10	4
18.	13	1	38.	11	3	58.	14	0
19.	12	2	39.	12	2	59.	14	0
20.	13	1	40.	8	6	60.	13	1

Item Analysis of Exit Math Competencies for Electronics (continued)

Item No.	Needed	Not Needed	Item No.	Needed	Not Needed	Item No.	Needed	Not Needed
61.	12	2	88.	14	0	115.	14	0
62.	11	3	89.	14	0	116.	11	3
63.	13	1	90.	13	1	117.	11	3
64.	11	3	91.	14	0	118.	11	3
65.	14	0	92.	14	0	119.	13	1
66.	13	1	93.	14	0	120.	14	0
67.	13	1	94.	13	1	121.	14	0
68.	11	3	95.	14	0	122.	14	0
69.	11	3	96.	14	0	123.	14	0
70.	10	4	97.	14	0	124.	14	0
71.	9	5	98.	14	0	125.	14	0
72.	10	4	99.	13	1	126.	14	0
73.	11	3	100.	12	2	127.	14	0
74.	8	6	101.	12	2	128.	13	1
75.	5	9	102.	13	1	129.	13	1
76.	8	6	103.	12	2	130.	12	2
77.	8	6	104.	13	1	131.	14	0
78.	10	4	105.	13	1	132.	14	0
79.	14	0	106.	12	2	133.	14	0
80.	14	0	107.	12	2	134.	14	0
81.	8	6	108.	11	3	135.	14	0
82.	9	5	109.	11	3	136.	14	0
83.	8	6	110.	14	0	137.	14	0
84.	12	2	111.	14	0	138.	14	0
85.	12	2	112.	14	0	139.	14	0
86.	14	0	113.	13	1	140.	14	0
87.	12	2	114.	14	0	141.	14	0
						142.	14	0

Item Analysis of Exit Math Competencies for Graphic Arts (N = 4)

Item No.	Needed	Not Needed	Item No.	Needed	Not Needed	Item No.	Needed	Not Needed
1.	0	4	12.	3	1	23.	4	0
2.	4	0	13.	3	1	24.	4	0
3.	4	0	14.	4	0	25.	4	0
4.	0	4	15.	3	1	26.	4	0
5.	0	4	16.	4	0	27.	0	4
6.	0	4	17.	4	0	28.	4	0
7.	2	2	18.	4	0	29.	4	0
8.	2	2	19.	4	0	30.	4	0
9.	1	3	20.	4	0	31.	4	0
10.	2	2	21.	4	0			
11.	1	3	22.	4	0			

Item Analysis of Exit Math Competencies for Machine Shop (N = 11)

Item No.	Needed	Not Needed	Item No.	Needed	Not Needed	Item No.	Needed	Not Needed
1.	9	2	41.	4	7	81.	11	0
2.	5	6	42.	5	6	82.	11	0
3.	5	6	43.	3	8	83.	11	0
4.	4	7	44.	4	7	84.	11	0
5.	6	5	45.	10	1	85.	11	0
6.	2	9	46.	11	0	86.	11	0
7.	5	6	47.	11	0	87.	11	0
8.	5	6	48.	8	3	88.	11	0
9.	10	1	49.	11	0	89.	11	0
10.	11	0	50.	11	0	90.	11	0
11.	5	6	51.	11	0	91.	11	0
12.	4	7	52.	5	6	92.	10	1
13.	6	5	53.	11	0	93.	11	0
14.	2	9	54.	5	6	94.	11	0
15.	4	7	55.	7	4	95.	11	0
16.	3	8	56.	5	6	96.	11	0
17.	4	7	57.	6	5	97.	10	1
18.	4	7	58.	11	0	98.	11	0
19.	3	8	59.	3	8	99.	11	0
20.	2	9	60.	0	11	100.	11	0
21.	3	8	61.	0	11	101.	11	0
22.	5	6	62.	0	11	102.	11	0
23.	5	6	63.	0	11	103.	11	0
24.	7	4	64.	0	11	104.	10	1
25.	7	4	65.	0	11	105.	11	0
26.	9	2	66.	0	11	106.	10	1
27.	7	4	67.	1	10	107.	11	0
28.	7	4	68.	1	10	108.	11	0
29.	7	4	69.	1	10	109.	11	0
30.	6	5	70.	1	10	110.	10	1
31.	7	4	71.	0	11	111.	11	0
32.	7	4	72.	1	10	112.	11	0
33.	4	7	73.	1	10	113.	11	0
34.	4	7	74.	1	10	114.	10	1
35.	4	7	75.	1	10	115.	11	0
36.	2	9	76.	0	11	116.	8	3
37.	7	4	77.	0	11	117.	9	2
38.	2	9	78.	10	1	118.	10	1
39.	4	7	79.	11	0	119.	11	0
40.	1	10	80.	11	0	120.	11	0

Item Analysis of Exit Math Competencies for Masonry (N = 1)

Item No.	Needed	Not Needed	Item No.	Needed	Not Needed	Item No.	Needed	Not Needed
1.	1	0	16.	1	0	31.	1	0
2.	1	0	17.	1	0	32.	1	0
3.	1	0	18.	1	0	33.	1	0
4.	1	0	19.	1	0	34.	1	0
5.	1	0	20.	1	0	35.	1	0
6.	0	1	21.	1	0	36.	1	0
7.	0	1	22.	1	0	37.	1	0
8.	0	1	23.	1	0	38.	1	0
9.	0	1	24.	1	0	39.	1	0
10.	0	1	25.	1	0	40.	1	0
11.	0	1	26.	1	0	41.	1	0
12.	0	1	27.	1	0	42.	1	0
13.	0	1	28.	1	0	43.	1	0
14.	0	1	29.	1	0	44.	1	0
15.	0	1	30.	1	0	45.	1	0

Item Analysis of Exit Math Competencies for Welding (N = 8)

Item No.	Needed	Not Needed	Item No.	Needed	Not Needed	Item No.	Needed	Not Needed
1.	2	6	14.	8	0	27.	7	1
2.	2	6	15.	8	0	28.	8	0
3.	2	6	16.	8	0	29.	7	1
4.	5	3	17.	8	0	30.	2	6
5.	6	2	18.	2	6	31.	2	6
6.	6	2	19.	8	0	32.	2	6
7.	5	3	20.	8	0	33.	8	0
8.	8	0	21.	8	0	34.	7	1
9.	7	1	22.	8	0	35.	6	2
10.	7	1	23.	8	0	36.	4	4
11.	8	0	24.	8	0	37.	5	3
12.	8	0	25.	8	0			
13.	8	0	26.	8	0			

Appendix 3

Competencies Not Selected

Competencies Not Selected For Air Conditioning (N = 12)

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2 Represent the products of two numbers on a graph.

3. Find the value of a radius vector graphically.

4. Represent trigometric functions by graphing.

5. Find the values of x and y on a graph.

6. Solve two simultaneous equations by graphing.

7. Convert a whole number to a positive power of ten.

8. Add, subtract, multiply, and divide positive and negative powers of ten.

9. Square a monomial.

10. Cube a monomial.

11. Take the square root of a monomial.

12. Find the cube root of a monomial.

13. Square a binomial.

14. Take the square root of a trinomial.

15. Divide numbers with exponents.

16. Multiply a number with an exponent by an exponent.

17. Multiply a fraction with an exponent by an exponent.

18. Express numbers with negative exponents as numbers with positive exponents.

19. Find the values of numbers with fractional exponents.

20. Simplify radicals containing fractions.

21. Add and subtract radicals.

22. Group terms in an equation.

23. Determine signs in a complex equation.

24. Solve equations with one unknown.

25. Solve equations by transposing.
26. Solve an equation by canceling a term.
27. Check solutions for equations.
28. Form equations from observed data.
30. Solve a problem involving 2 formulas, 3 or more knowns, and one unknown.
31. Solve a problem involving 3 formulas, 3 or more knowns, and one or more unknown.
32. Solve a quadradic equation.
33. Solve equations with the quadradic formula.
34. Solve quadradic equations by graphing.
35. Factor a simple equation.
36. Find the prime factors of equations.
37. Find the product of two equations.
38. Divide two quadradic equations.
39. Solve simultaneous linear equations.
40. Solve simultaneous equations by comparison.
41. Solve fractional form simultaneous equations.
42. Determine complementary and supplementary angles of a triangle.
45. Determine metric numbers that represent the SI prefix symbols.
46. Determine metric prefix names for prefix symbols.
47. Find the equivalent value in metrics of a value with a prefix symbol.
48. Determine customary lengths for selected metric lengths.
49. Convert lengths from English to metric.

50. Convert dimensions of objects from English to metric.

52. Compute metric volumes.

53. Convert customary dimensions to metric dimensions and calculate the volume in metric units.

54. Use vector diagrams to find instantaneous values in an AC circuit.

56. Draw vector diagrams of circuits.

58. Find the perimeter of a polygon.

60. Subtract with degrees, minutes, and seconds.

62. Find the area of a circle, triangle, square, parallelogram, and rectangle.

63. Reason what occurs from a formula when variables are increased/decreased.

66. Solve problems using $<$, $>$, $\leq$, $\geq$.

69. Solve problems with prefixes, units, and numbers.

71. Read x and y values from complex graphs (five or more lines).

74. Calculate proportions of solids to liquids.

Competencies Not Selected For Auto Body (N = 11)

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2. Find the square inches of a rectangle.
3. Determine metric numbers that represent the SI prefix symbols.
4. Determine metric prefix names for prefix symbols.
5. Find the equivalent value in metrics of a value with a prefix symbol.
6. Determine customary lengths for selected metric lengths.
7 Convert lengths from English to metric.
8. Convert dimensions of objects from English to metric.
9. Convert area measurements to metric areas.
10. Convert fractions to decimals.
11. Convert decimals to fractions.
13. Find the area of a square and a rectangle.
18. Find the diameter of a circle.
19. Find the radius of a circle.
23. Find the diagonal of a square.
30. Determine sheet metal tolerances from a blueprint.
31. Determine the minimum pipe size needed for a compressing outfit.

Competencies Not Selected For Auto Mechanics (N = 13)

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13. Determine the sizes of angles on drawings.

15. Calculate the tolerance for mash in a car frame.

26. Determine the work needed to raise an engine, using the formula for work.

27. Determine the power needed to move a given car.

30. Calculate the indicated horsepower.

31. Calculate the frictional horsepower.

32. Calculate net horsepower.

33. Calculate gross horsepower.

34. Calculate taxable horsepower.

35. Calculate volumetric efficiency.

36. Calculate mechanical efficiency.

37. Calculate thermal efficiency.

38. Determine engine torque.

41. Read a refractometer.

Competencies Not Selected For Drafting (N = 12)

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4. Represent trigometric functions by graphing.
6. Solve two simultaneous equations by graphing.
8. Add, subtract, multiply, and divide positive and negative powers of ten.
11. Square a monomial.
12. Cube a monomial.
13. Take the square root of a monomial.
14. Find the cube root of a monomial.
15. Square a binomial.
16. Take the square root of a trinomial.
18. Multiply a number with an exponent by an exponent.
19. Multiply a fraction with an exponent by an exponent.
20. Express numbers with negative exponents as numbers with positive exponents.
21. Find the values of numbers with fractional exponents.
22. Simplify radicals containing fractions.
23. Add and subtract radicals.
25. Determine signs in a complex equation.
33. Solve a problem involving 3 formulas, 3 or more knowns, and one or more unknown.
34. Solve a quadradic equation.
35. Solve equations with the quadradic formula.
36. Solve quadradic equations by graphing.
37. Factor a simple equation.
38. Find the prime factors of equations.

39. Find the product with the difference and sum of two equations.
40. Factor the sum and difference of 2 cubes.
41. Solve simultaneous linear equations by addition and subtraction.
42. Solve simultaneous linear equations by substitution.
43. Solve simultaneous equations by comparison.
44. Solve fractional form simultaneous equations.
52. Solve graphically for elements of a right triangle.
54. Find the least common multiple.
56. Change sign of fractions.
59. Set up equations from theory.
60. Express equations in logarithmic form.
61. Find the logarithm of a product.
62. Find the logarithm of a quotient.
63. Find the logarithm of a power.
64. Find the logarithm of a root.
65. Find the logarithm of a number.
66. Express equations in exponential form.
67. Find the antilog of a number.
68. Add logarithms.
69. Subtract logarithms.
70. Multiply logarithms.
71. Compute logarithms with negative numbers.
72. Division by logarithms.
73. Multiplication and division by logarithms.
74. Extracting roots by logarithms.

75. Compute equations using logarithms with fractional exponents.

76. Graph a logarithm function.

List the side and or angle relationships for the following:

103. Nonagon.

104. Decagon.

105. Dodecagon.

106. Tetrahedron.

107. Hexahedron.

108. Octahedron.

109. Dodecahedron.

110. Icosohedron.

113. Right triangular prism.

114. Right rectangular prism.

115. Right pentagonal prism.

116. Oblique pentagonal prism.

117. Oblique hexagonal prism.

List the elements of the following:

118. Right circular cylinder.

119. Oblique circular cylinder.

120. Right triangular pyramid.

121. Right square pyramid.

122. Oblique pentagonal pyramid.

123. Right circular cone.

124. Oblique circular cone.

125. Sphere.

126. Torus.

Competencies Not Selected For Electricity (N = 12)

---

2. Represent the products of two numbers on a graph.
3. Find the value of a radius vector graphically.
4. Represent trigometric functions by graphing.
5. Determine x and y intercepts on a graph.
6. Solve two simultaneous equations by graphing.
8. Add, subtract, multiply, and divide positive and negative powers of ten.
11. Square a monomial.
12. Cube a monomial.
14. Find the cube root of a monomial.
15. Square a binomial.
16. Take the square root of a trinomial.
17. Multiply and divide numbers with exponents.
18. Multiply a number with an exponent by an exponent.
19. Multiply a fraction with an exponent by an exponent.
20. Express numbers with negative exponents as numbers with positive exponents.
21. Find the values of numbers with fractional exponents.
22. Simplify radicals containing fractions.
23. Add and subtract radicals.
24. Group terms in an equation.
25. Determine signs in a complex equation.
28. Solve an equation by canceling a term.

32. Solve a problem involving 2 formulas, 3 or more knowns, and one unknown.
33. Solve a problem involving 3 formulas, 3 or more knowns, and one unknown.
34. Solve a quadradic equation.
35. Solve equations with the quadradic formula.
36. Solve quadradic equations by graphing.
38. Find the prime factors of equations.
39. Find the product with the difference and sum of two equations.
40. Factor the sum and difference of 2 cubes.
41. Solve simultaneous linear equations by addition and subtraction.
42. Solve simultaneous linear equations by substitution.
43. Solve simultaneous equations by comparison.
44. Solve fractional form simultaneous equations.
48. Find the functions of an angle in second, third and fourth quadrants.
50. Find trigometric ratios of angles of right triangles.
52. Solve graphically for elements of a right triangle.
54. Find the least common multiple.
55. Reduce a fraction to its lowest term.
56. Change the sign of fractions.
57. Add, subtract, multiply, and divide fractions.
60. Express equations in logarithmic form.
61. Find the logarithm of a product.
62. Find the logarithm of a quotient.

63. Find the logarithm of a power.
64. Find the logarithm of a root.
65. Find the logarithm of a number.
66. Express equations in exponential form.
67. Find the antilog of a number.
68. Add logarithms.
69. Subtract logarithms.
70. Multiply logarithms.
71. Compute logarithms with negative numbers.
72. Division by logarithms.
73. Multiplication and division by logarithms.
74. Extracting roots by logarithms.
75. Compute equations using logarithms with fractional exponents.
76. Graph a logarithm function.
77. Solve a logarithmic equation.
78. Solve electronic problems using logarithms.
79. Express gain or loss of apparatus in decibels.
80. Express gain or loss of quantities in decibels.
81. Find the inductance of a line using logarithms.
82. Find the impedance of a line using logarithms.
83. Find the capacitance of a line using logarithms.
84. Graph the equation $y = \sin x$.
85. Graph the cosine curve.
86. In equations of periodic curves, specify frequency.
87. In equations of periodic curves, specify angle of velocity.

88. In equations of periodic curves, specify the amplitude.
89. In equations of periodic curves, specify the period.
90. In equations of periodic curves, specify angle of lead or lag.
94. Use vector diagrams to find instantaneous values in an AC circuit.
95. Determine angles in a vector diagram of an AC circuit.
96. Find the angular velocity of an AC circuit.
99. Determine angles in a vector diagram and plot imaginary numbers on a vector diagram.
100. Express AC circuit parameters in polar form.
101. Convert AC circuit parameters from rectangular to polar form and visa versa.
102. Solve problems using parameters expressed in polar form.
103. Solve problems using parameters expressed in polar form.
104. Add vectors in rectangular form.
105. Subtract vectors in rectangular form.
106. Multiply vectors in rectangular form.
107. Divide vectors in rectangular form.
108. Myltiply polar vectors.
109. Divide polar vectors.
111. Construct and analyze truth tables.
112. Develop a Boolean equation from a logic diagram.
113. Use the sum of products method to solve a Boolean equation.
114. Develop a sum of products equation from a truth table.
115. Simplify a Boolean equation.

116. Convert a truth table into a Karnough map.
117. Draw a three and four variable Karnough map from a truth table.
118. Simplify a Karnough map by using octets, quads, or pairs.
119. Use the product of sums method to simplify a truth table.
120. Convert a truth table to an equation.
121. Simplify a product of sums equation.
122. Use multiplexer logic.
123. Find BCD equivalents of decimal numbers.
124. Convert binary numbers to decimal equivalents.
125. Convert octal numbers to decimal equivalents.
126. Find the decimal equivalent of an octal number.
127. Convert hexadecimal numbers to binary numbers.
128. Express a decimal number in excess - 3 code.
129. Express an excess - 3 number as a decimal equivalent.
130. Convert Gray numbers to decimal equivalent.
131. Give the sum of numbers in base 8 or 16.
132. Sum of binary numbers.
133. Add whole numbers in base 10 using 16 bit numbers.
134. Subtract binary numbers.
135. Subtract whole numbers in the base ten system.
136. Determine overflow of problems with 8 bit unsigned arithmetic.
137. Express positive or negative whole numbers in 8 bit sign magnitude form.

138. Convert sign magnitude numbers into decimal equivalents.

139. Express the complement of numbers in hexadecimal notation.

140. Express the 2's complement of binary numbers.

141. Convert positive or negative whole numbers to 2's complement representation.

142. Show the 8 bit addition and subtraction of decimal numbers in 2's complement representation.

Competencies Not Selected For Electronics (N = 14)

---

11. Square a monomial.
12. Cube a monomial.
14. Find the cube root of a monomial.
16. Take the square root of a trinomial.
22. Simplify radicals containing fractions.
23. Add and subtract radicals.
24. Group terms in an equation.
36. Solve quadradic equations by graphing.
40. Factor the sum and difference of two cubes.
54. Find the least common multiple.
55. Reduce a fraction to its lowest term.
56. Change the sign of fractions.
57. Add, subtract, multiply and divide fractions.
70. Multiply logarithms.
71. Compute logarithms with negative numbers.
72. Division by logarithms.
74. Extracting roots by logarithms.
75. Compute equations using logarithms with fractional exponents.
76. Graph a logarithm function.
77. Solve a logarithm function.
81. Find the inductance of a line using logarithms.
82. Find the impedance of a line using logarithms.
83. Find the capacitance of a line using logarithms.

Competencies Not Selected For Graphic Arts (N = 4)

---

1. Find the area of a square, rectangle.
4. Determine metric numbers that represent the SI prefix symbols.
5. Determine metric prefix names for prefix symbols.
6. Find the equivalent value in metrics of a value with a prefix symbol.
7. Determine customary lengths for selected metric lengths.
8. Convert lengths from English to metric.
9. Convert dimensions of objects from English to metric.
10. Convert area measurements to metric areas.
11. Find the square inches of a rectangle.
27. Determine the paper postion on the tympan of a platen press.

Competencies Not Selected For Machine Shop (N = 11)

---

2. Represent the products of two numbers on a graph.
3. Find the value of a radius vector graphically.
4. Represent trigometric functions by graphing.
5. Determine x and y intercepts on a graph.
6. Solve two simultaneous equations by graphing.
7. Convert a whole number to a positive power of ten.
8. Add, subtract, multiply and divide positive and negative powers of ten.
11. Square a monomial.
12. Cube a monomial.
13. Take the square root of a monomial.
14. Find the cube root of a monomial.
15. Square a binomial.
16. Take the square root of a trinomial.
17. Multiply and divide numbers with exponents.
18. Multiply a number with an exponent by an exponent.
19. Multiply a fraction with an exponent by an exponent.
20. Express numbers with negative exponents as numbers with positive exponents.
21. Find the values of numbers with fractional exponents.
22. Simplify radicals containing fractions.
23. Add and subtract radicals.
24. Group terms in an equation.
25. Determine signs in a complex equation.

27. Solve equations by transposing.
28. Solve an equation by canceling a term.
29. Check solutions for equations.
30. Form equations from observed data.
31. Solve a problem using a formula with knowns and one unknown expressed in the same unit.
32. Solve a problem involving 2 formulas, 3 or more knowns, and one unknown.
33. Solve a problem involving 3 formulas, 3 or more knowns, and one or more unknown.
34. Solve a quadradic equation.
35. Solve equations with the quadradic formula.
36. Solve quadradic equations by graphing.
37. Factor a simple equation.
38. Find the prime factors of equations.
39. Find the product with the difference and sum of two equations.
40. Factor the sum and difference of 2 cubes.
41. Solve simultaneous linear equations by addition and subtraction.
42. Solve simultaneous linear equations by substitution.
43. Solve simultaneous linear equations by comparison.
44. Solve fractional form simultaneous equations.
48. Find functions of an angle in second, third, and fourth quadrants.
52. Solve graphically for elements of a right triangle.
54. Find the least common multiple.

55. Reduce a fraction to its lowest terms.

56. Change the sign of fractions.

57. Add, subtract, multiply and divide fractions.

59. Set up equations from theory.

60. Express equations in logarithmic form.

61. Find the logarithm of a product.

62. Find the logarithm of a quotient.

63. Find the logarithm of a power.

64. Find the logarithm of a root.

65. Find the logarithm of a number.

66. Express equations in exponential form.

67. Find the antilog of a number.

68. Add logarithms.

69. Subtract logarithms.

70. Multiply logarithms.

71. Compute logarithms with negative numbers.

72. Division by logarithms.

73. Multiplication and division by logarithms.

74. Extracting roots by logarithms.

75. Compute equations using logarithms with fractional exponents.

76. Graph a logarithm function.

77. Solve a logarithmic equation.

Competencies Not Selected For Masonry (N = 1)

---

6. Determine metric numbers that represent the SI prefix symbols.
7. Determine metric prefix names for prefix symbols.
8. Find the equivalent value in metrics of a value with a prefix symbol.
9. Determine customary lengths for selected metric lengths.
10. Convert units in the metric system.
11. Convert lengths from metric to English.
12. Calculate the areas of objects from English to metric.
13. Convert lengths from metric to English.
14. Convert dimensions of objects from English to metric.
15. Convert areas measurements to metric areas.

Competencies Not Selected For Welding (N = 8)

---

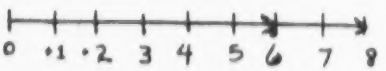
1. Determine metric numbers that represent the SI prefix symbols.
2. Determine metric prefix names for prefix symbols.
3 Find the equivalent value in metrics of a value with a prefix symbol.
4. Determine customary lengths for selected metric lengths
7. Convert area measurements to metric areas.
18. Convert temperatures in Farenheit to Celsius.
30. Calculate the rated load voltage for class I and II arc welding machines.
31. Calculate the electrical power input requirements for class I and II transformer arc welders.
32. Read voltmeter and ammeters.
36. Determine the velocity (in ft./sec, m/sec) of different coating materials used in the thermal spray process.
37. Determine the pressure in a tank or cylinder given the outside temperature.

Appendix 4

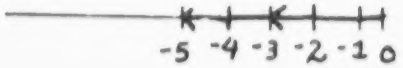
Examples of Competencies

EXAMPLES FOR COMMON MATH COMPETENCIES

1. $6 - (-2) = 8$



$-3 - 2 = -5$



9. $4^{\frac{1}{2}} = 16$

$25^{\frac{1}{2}} = 625$

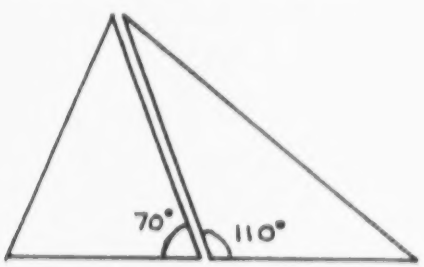
10. $\sqrt{10} = 3.1623$

$\sqrt{40} = 6.3245$

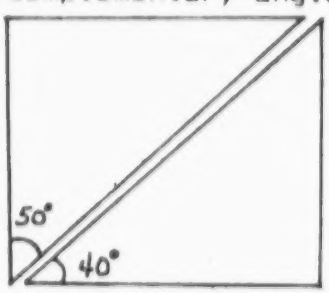
26. $2x = 1$
$x = 1/2$

$4y = 2$
$y = 1/2$

45. Supplementary angles



Complementary angles



46. $\sin \theta = \frac{\text{opposite leg}}{\text{hypotenuse}}$

$\sin 30^\circ = .5$
$\sin 60^\circ = .866$

$\cos \theta = \frac{\text{adjacent side}}{\text{hypotenuse}}$

$\cos 30^\circ = .866$
$\cos 60^\circ = .5$

47. $\tan 175^\circ = -\tan (180^\circ - 175^\circ) = -\tan 5^\circ = -.0875$
$\tan 234^\circ = \tan (234^\circ - 180^\circ) = \tan 54^\circ = 1.3764$

49. $b = 3 \quad c = 5 \quad A = 53.1^\circ \quad a = ? \quad B = ? \quad C = ?$
$a = 4 \quad B = 36.9^\circ \quad C = 90^\circ$

$a = 8 \quad b = 5 \quad C = 34^\circ \quad c = ? \quad A = ? \quad B = ?$
$c = 4.75 \quad A = 110^\circ \quad B = 36^\circ$

51. Given : $R = 30 \quad \theta = 25^\circ$ Solve for z, x, and ϕ

$\phi = 90^\circ - \theta$
$\phi = 65^\circ$

$\tan \theta = \frac{x}{R}$

$x = R \tan \theta$

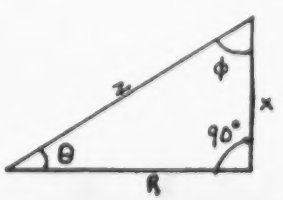
$x = 30 \times .466 = 14$

$\sin \theta = \frac{x}{z}$

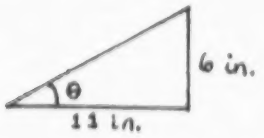
$z = \frac{x}{\sin \theta}$

$z = \frac{14}{.423}$

$z = 33.1$



53. What is the angle of inclination of a stairway with the floor if the steps have a tread of 11 in. and a rise of 6 in. ?

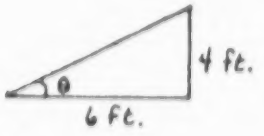


$$\tan \theta = \frac{x}{R}$$

$$\tan \theta = \frac{6}{11} = .545$$

$$\theta = 28.6^\circ$$

What angle does a rafter make with the original horizontal if it has a rise of 4 ft. in a run of 6 ft ?



$$\tan \theta = \frac{x}{R}$$

$$= \frac{4}{6} = .6667$$

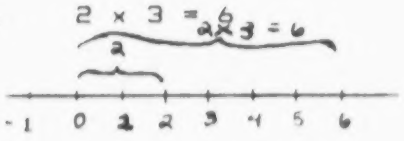
$$\theta = 33.7^\circ$$

58. $\frac{3}{2} = 1.5$ $\qquad \frac{697}{4181} = .1667$

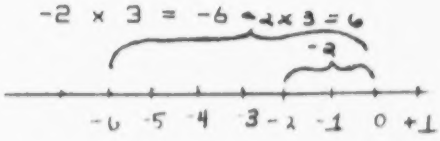
EXAMPLES FOR DRAFTING MATH COMPETENCIES (N = 12)

---

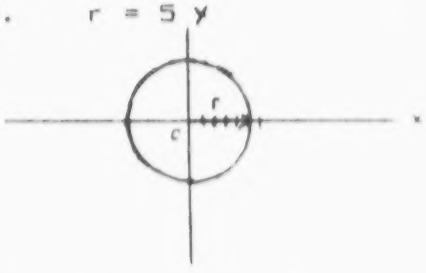
2. $2 \times 3 = 6$ $\quad 2 \times 3 = 6$



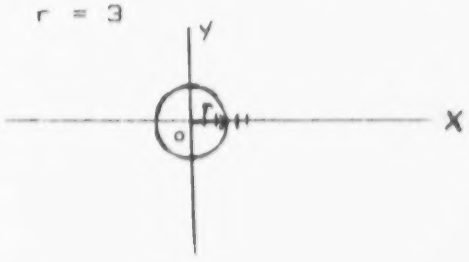
$-2 \times 3 = -6$ $\quad -2 \times 3 = 6$



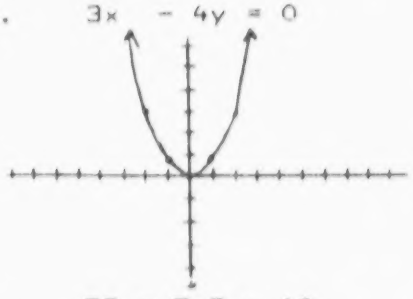
3. $r = 5$ $\quad y$



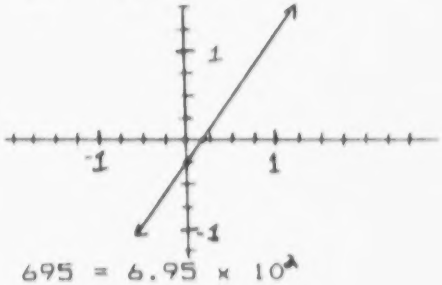
$r = 3$



5. $3x - 4y = 0$



$6x - 4y = 1$



7. $52 = 5.2 \times 10$ $\qquad 695 = 6.95 \times 10^{2}$

17. $a^{5} \times a^{6} = a^{11}$ $\qquad b^{4}/b^{3} = b$

24. $3x^{2} - 9xy^{2} = 3x(x - 3y^{2})$ $\qquad 2a - 6a^{2}b + 4ax - 10ay^{3} = 2a(1 - 3ab + 2x - 5y^{3})$

27. $x + 5 = 10$
$x = 10 - 5$
$x = 5$

$3i + 5 = 20$
$3i = 15$
$i = 15$

28. $x - z = 2 - z$
$x = 2$

$y + x = 14 + x$
$y = 14$

29. $4x + 3 = 15$
$x = 3$
Check:
$4(3) + 3 = 15$
$12 + 3 = 15$

$9y + 6 = 24$
$y = 2$
Check:
$9(2) + 6 = 24$
$18 + 6 = 24$

30. $E = 30\ v$

$R = 5$

$I = \frac{E}{R}$

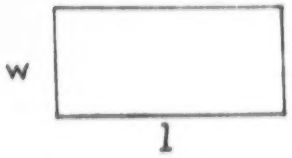
Use $I = \frac{E}{R}$

width = 4 length = 6

Find the perimeter

$P = (2l + 2w)$

$= 2(4 + 6) = 2(10) = 20$



31. pitch diameter = 128 pitch diameter = 216

Sum of the two pitch diameter = 128 + 216 = 344

pitch cone angle = 45° addendum angle = 22.5°

face angle = pich cone angle + addendum angle

face angle = 45 + 22.5 = 67.5°

32. Mo = 6.15 N = 32

pitch diameter = N x Mo = 32 x 6.15 = 196.8 mm

OD = D + 2A = 196.8 + 2(6.15) = 209.1 mm

Mo = D/N CP = 3.1416 x Mo

D = 7.0 N = 12

Mo = 7.0/12 = .5833

CP = 3.1416 x .5833 = 1.8326

48. Second quadrant:

$\sin 140^\circ = \sin(180^\circ - 140^\circ) = \sin 40^\circ = .6428$

$\cos 100^\circ = -\cos(180^\circ - 100^\circ) = -\cos 80^\circ = -.1736$

Third quadrant:

$\sin 200^\circ = -\sin(200^\circ - 180^\circ) = -\sin 20^\circ = -.3420$

$\cos 260^\circ = -\cos(260^\circ - 180^\circ) = -\cos 80^\circ = -.1736$

Fourth quadrant:

$\sin 300^\circ = -\sin(360^\circ - 300^\circ) = -\sin 60^\circ = -.8660$

$\cos 285^\circ = \cos(360^\circ - 285^\circ) = \cos 75^\circ = .2588$

50. $\sin 26.44^\circ = .4452$ $\sin 13.6^\circ = .2351$

$\cos 88.1^\circ = .0332$ $\tan 48.8^\circ = 1.1423$

55. $\frac{14\,x^3y^2z}{7\,x^2y} = 2xyz$ $\frac{64\,x^4y^3z^4}{8\,x^1yz^3} = 8\,x^3y^4$

57. $\frac{e^3}{4} - 4 = \frac{e^3 - 16}{4}$ $\frac{\frac{12x^4}{y^3}}{\frac{4x^3}{3y^5}} = \frac{9y^4}{x}$

77. $4\log x + 3.796 = 4.6990 + \log x$

$4\log x - \log x = 4.6990 - 3.7960$

$3\log x = .9030$

$\log x = .3010$

$x = 2$

$$500 = 276 \log \frac{d}{.05}$$

$500 = 276 (\log d - \log .05)$

$1.81 = \log d - \log .05$

$\log d = 1.81 + \log .05$

$\log d = 1.81 + 8.6990 - 10$

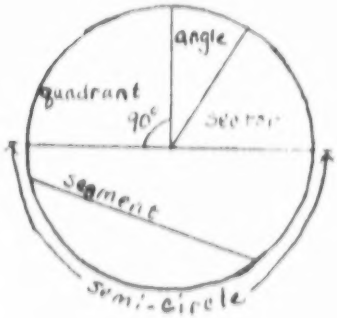
$\log d = .5090$

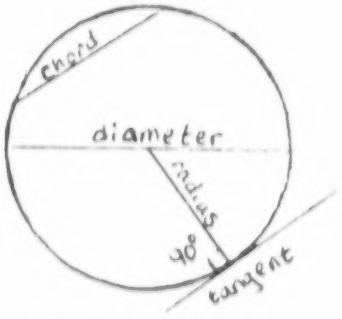
$d = 3.23$

78. scale: full size (1/1) 5" = 5"

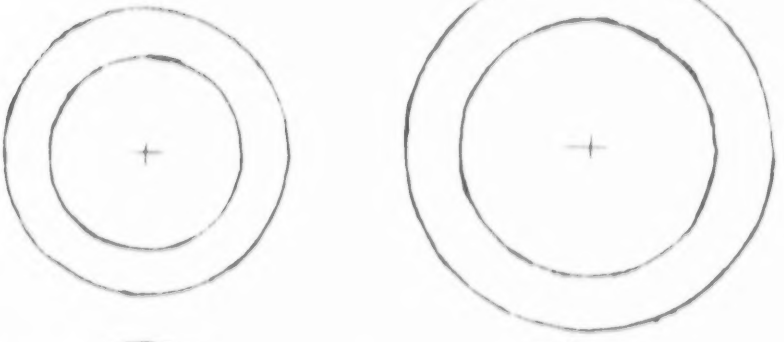
scale: half size (1/2) 6" = 3"

79.

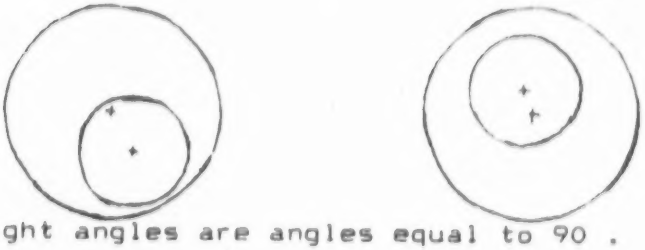




80.

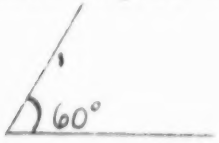


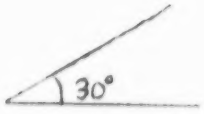
81.



82. Right angles are angles equal to 90 .

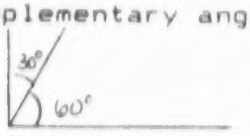
83. Acute angles are angles less than 90 .

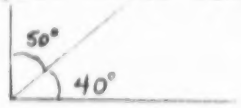




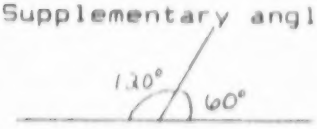
84. Obtuse angles are angles that are more than 90 .

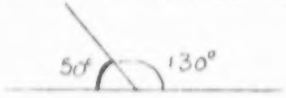
85. Complementary angles are angles whose sum equals 90 .





86. Supplementary angles are angles whose sum is 180 .





87. radius = 5 diameter = 10
circumference = 3.1416 x 10
= 31.416
radius = 7.5 diameter = 15
circumference = 3.1416 x 15
= 47.124

area = 3.1416 x r^2
= 3.1416 x 5^2
= 78.54
area = 3.1416 x r^2
= 3.1416 x 7.5^2
= 176.715

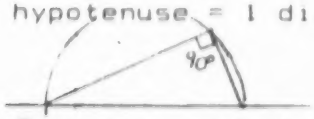
88. Equilateral triangle : all sides and angles are equal.

89. Isosceles triangle : two sides are equal and base angles are equal.

90. Scalene triangle : one angle is obtuse.

91. Right angle : one angle is 90°.

92. hypotenuse = 1 diameter



93. Square : all sides are equal; all angles are 90 .

94. Rectangle : opposite sides are equal; all angles are 90 .

95. Rhombus : all sides are equal.

96. Rhomboid : adjacent sides are unequal.

97. Trapezoid : two sides are parallel.

98. Trapezium : no sides are parallel.

99. Pentagon : a polygon with five sides and five interior angles.

100. Hexagon : a six sided polygon.

101. Heptagon : a seven sided polygon.

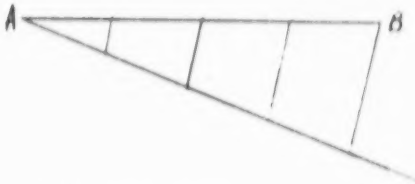
102. Octagon : an eight sided polygon.

111. Right square : all sides are equal, opposite sides are parallel, all angles 90°.

112. Oblique triangle : a triangle with no angles equal to 90°.

118. Right circular cylinder : two faces are circular with a curved surface and the axis at a 90° angle.

127.



128. (See textbook of your choice.)

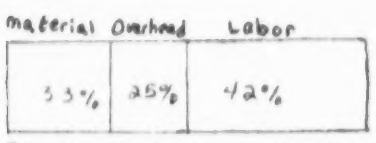
129. (See textbook of your choice.)

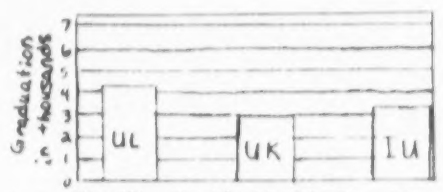
130. (See textbook of your choice.)

131. (See textbook of your choice.)

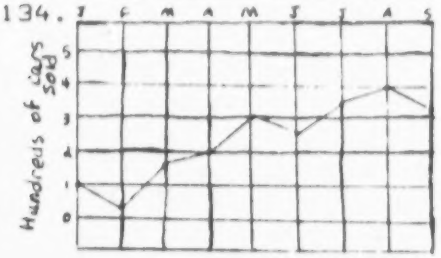
132. (See textbook of your choice.)

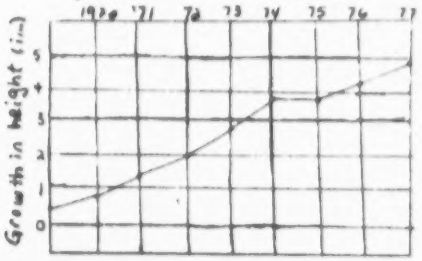
133.



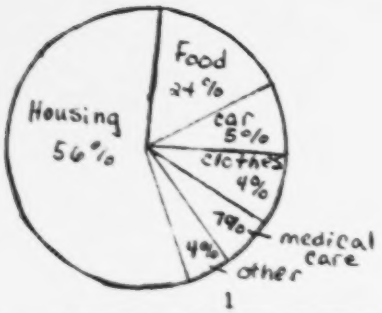


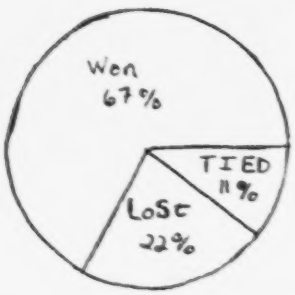
134.





135.





136. $P = \frac{1}{\text{no. of threads per inch}}$

threads/inch = 32
P = 1/32

threads/inch = 40
P = 1/40

137. Circular pitch of a thread
P = 1/N N = 2 P = 1/2 = .5
N = 8 P = 1/8 = .125

138. (See textbook of your choice)

139. Diametral pitch of a gear

$P = \frac{N}{D}$ N = 48 D = 8 P = 6

N = 60 D = 10 P = 6

140.

$CP = \frac{3.1416\ D}{N}$

P = 4
CP = .7854

$CP = \frac{3.1416}{P}$

P = 5
CP = .6283

141. $D = \frac{N}{P}$ (inches)

N = 32 P = .125
$D = \frac{32}{.125}$
D = 256

D = Mo x N (metric)
N = 45 Mo = 7.35
D = 45 x 7.35
D = 330.75

142. OD = D + 2A = D + 2Mo

N = 36 P = 6
$OD = \frac{(36 + 2)}{6}$
OD = 6.33

N = 42 P = 4
$OD = \frac{(42 + 2)}{4}$
OD = 11

143. $RD = D - 2B = \frac{(N - 2.314)}{P}$

N = 72 P = 12
$RD = \frac{(72 - 2.314)}{12} = 5.8072$

N = 60 P = 10
$RD = \frac{(60 - 2.314)}{10} = 5.768$

144. Addendum
A = Mo = I/P
I = .8 P = .1122
A = .8/.1122 = 7.125

I = .8 Mo = 6.875
A = .8 x 6.875 = 5.5

145. $B = Mo = I/P = 1.57 \times Mo$

$Mo = 6.35$ $\qquad$ $Mo = 5.67$

$B = 1.157 \times 6.35 = 7.347$ $\qquad$ $B = 1.157 \times 5.67 = 6.561$

146. $WD = 2.157 \times Mo$ $\qquad$ $WD = 1.8/P$

$Mo = 6.331$ $\qquad$ $P = 9.7$

$WD = 2.157 \times 6.331$ $\qquad$ $WD\ 1.8/9.7$

$WD = 13.656$ $\qquad$ $WD = .1855$

147. Circular Thickness

$$T = \frac{3.1416\ D}{2N} = \frac{1.57}{P}$$

$N = 44 \qquad D = 4$ $\qquad$ $N = 24 \quad P=6$

$$T = \frac{(3.1416 \times 4)}{2(44)} \qquad T = \frac{1.57}{6}$$

$T = .1428$ $\qquad$ $T = .2617$

148.

Prefix	Number
giga	1,000,000,000
hecto	100
deci	0.1
micro	0.000001

149.

Prefix Symbols	Prefix Names
G	giga
da	deka
μ	micro
n	nano

150. Mmeter = 1,000,000 meters

μgram = .000001 gram

151. one inch = 25.4 mm = 2.54 cm
one foot = 304.8 mm = 30.48 cm
one yard = 1.2144 m
one mile = 1.609 km

152. 1m = 10 dm = 100 cm = 1000 mm
$1dm^3 = 100\ cm^3 = 1$ litre = 1000 ml
$1dm^3$ of water = 1 kg

153. 100 miles = (1.609 x 100) = 160.9 km
32 yards = (1.2144 x 32) = 38.761

154. The sides of a square are all 100 m long. What is the area of the square?
Area = (100 x 100) m^2 = 10,000 m^2
The base of a triangle is 25 cm and its height is 10 cm. What is the area of the triangle?
Area = 1/2(25 cm x 10 cm) = 125 cm^2

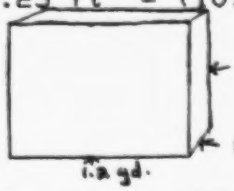
155. 64 km = (.621 × 64) miles = 39.74 miles
44 mm = (.039 × 44) inches = 1.716 inches

156. 2" × 4" = 50.8 × 101.6 mm = 5161.28 mm
10' × 10' = 304.8 × 304.8 cm = 92903.04 cm

157. 2.4 acres = 1 square hectometre (hectare)
52 acres = 20.8 hectares

158. 4.5 gallons = (3.785 × 4.5) litres = 17.0325 litres
10.25 ft^3 = (10.25 × .028) m^3 = .287 m^3

159.



1.2 yds = (1.2 × 1.2144m)
= 1.4573 m
2 ft = .6667 yd
= (.6667 × 1.2144m)
= .8096

volume = (1.4573m)(1.4573m)(.8096m) = 1.7194 m^3
2.2 ft = 67.056 cm
volume = $(2.2ft)^3$ = $(67.056\ cm)^3$ = 301517.78 cm^3
= 301.5178 dm^3

160.	millimeters 1:20	inches 1:24
161.	millimeters 1:5	inches 1:4
162.	millimeters 1:200	inches 1:192
163.	millimeters 1:1000	inches 1:1250
164.	millimeters 1:2000	inches 1:2500
165.	millimeters 1:10,000	inches 1:10,560

EXAMPLES FOR ELECTRICITY MATH COMPETENCIES (N = 12)

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7. $52 = 5.2 \times 10$ $\qquad 695 = 6.95 \times 10^{2}$

13. $\sqrt{4a^2b^2} = 2ab$ $\qquad \sqrt{25a^4b^2} = 5a^2b$

22. $\sqrt{4/9} = 2/3$ $\qquad \sqrt{16/25} = 4/5$

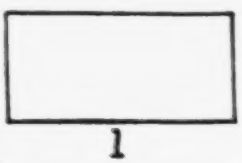
29. $4x + 3 = 15$
$x = 3$
Check:
$4(3) + 3 = 15$
$12 + 3 = 15$

$9y + 6 = 24$
$y = 2$
Check:
$9(2) + 6 = 24$
$18 + 6 = 24$

30. $E = 30$ v

$R = 5$
$I = \frac{E}{R}$
Use $I = \frac{E}{R}$

width = 4 length = 6
Find the perimeter
$P = (2l + 2w)$
$= 2(4 + 6) = 2(10) = 20$



31. R_1, R_2, R_3, R_4 are in a series.
$R_1 = 10\,\Omega$ $\quad R_2 = 20\,\Omega$ $\quad R_3 = 30\,\Omega$
$R_1 + R_2 + R_3 + R_4 = 100\,\Omega$
$10 + 20 + 30 + R_4 = 100\,\Omega$
$R_4 = 40$

$E_1 = 50$v $\quad E_2 = 125$v $\quad E_3 = 75$v
$E_c = E_1 + E_2 + E_3 = 50 + 125 + 75 = 250$v

37. $3x + 3yx = 1$
$3x(1 + y) = 1$

$27b^2a + 3cba = 0$
$3ba(9b + c) = 0$

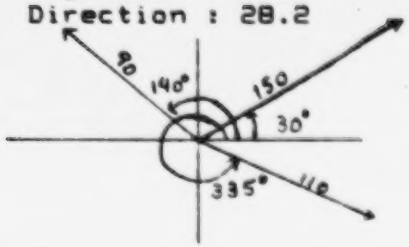
59. Ohm's Law :
Current is equal to the direct proportion of voltage to resistance.

$$I = \frac{E}{R}$$

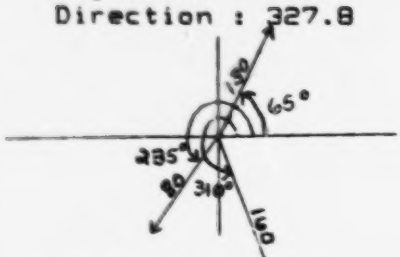
Kirchhoff's Law :
The algebraic sum of the currents at any junction of conductors is zero.

$$R_1I + R_2I + R_3I = 0$$

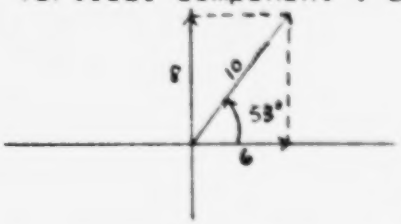
91. Magnitude : 182.5
Direction : 28.2



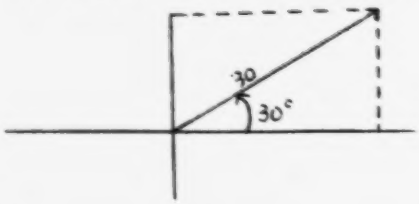
Magnitude : 132
Direction : 327.8



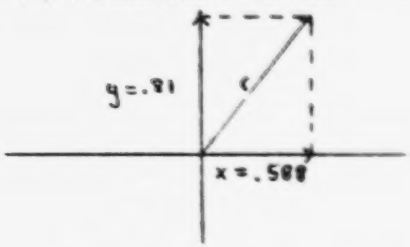
92. Horizontal component : 6
Vertical component : 8



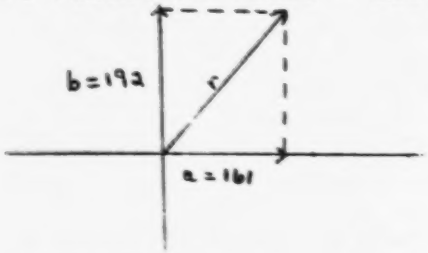
Horizontal component : 18
Vertical component : 24



93. r, resultant force = 1



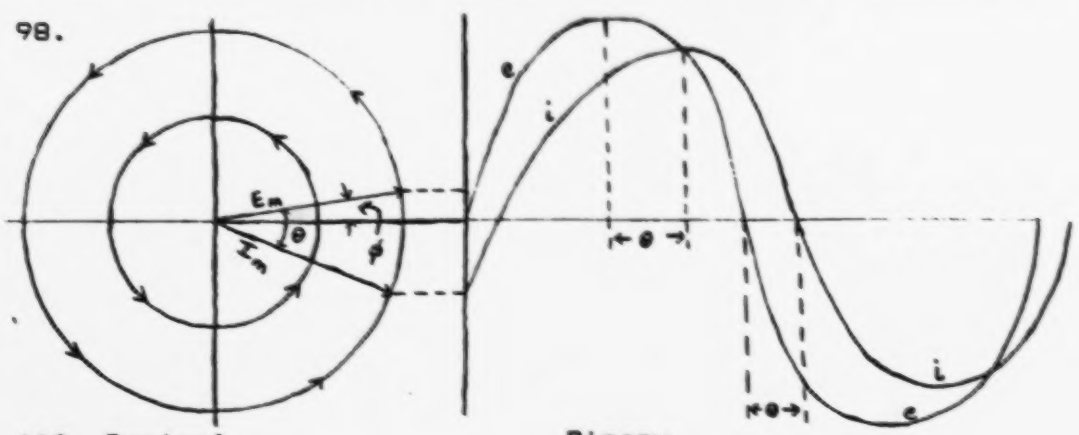
r, resultant force = 250



97. Maximum voltage : 170 v
Maximum current : 14.1 a
Frequency : 800
Phase angle : 40° lag
Voltage angle : 10°
e = 170 sin 5030t v
i = 14.1 sin (5030t - 40°)a

Maximum current : 14a
Maximum voltage : 220v
Phase angle : 60° lag
E = 2 E = 2 x 220 = 311v
o = 245° + θ = 245° + 60°
= 305° = -55°
e = 311 sin (-55°) = -255v

98.

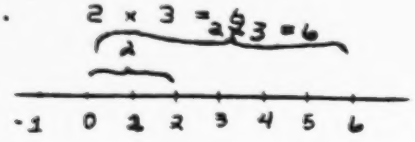


110.

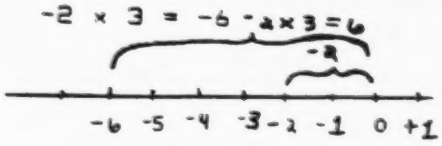
Decimal	Binary
4	0100
15	1111

EXAMPLES FOR ELECTRONICS MATH COMPETENCIES (N = 13)

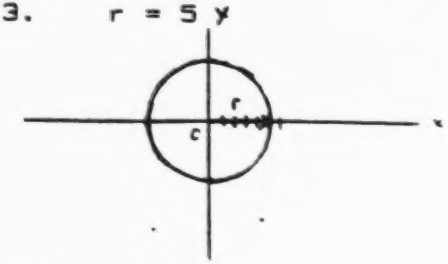
2. $2 \times 3 = 6$ $\quad 2 \times 3 = 6$



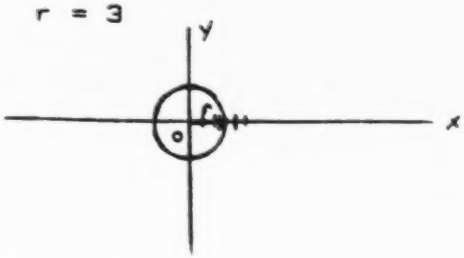
$-2 \times 3 = -6$ $\quad -2 \times 3 = 6$



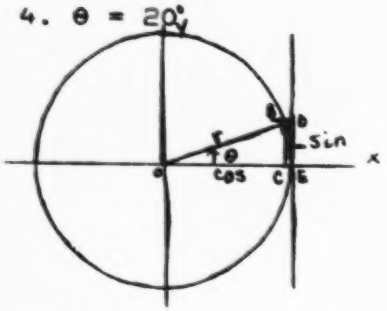
3. $r = 5$



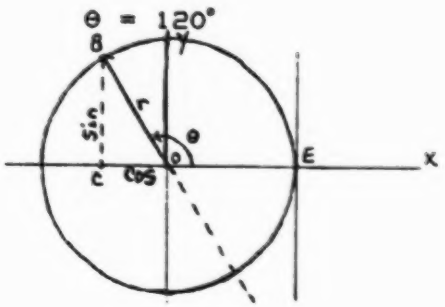
$r = 3$



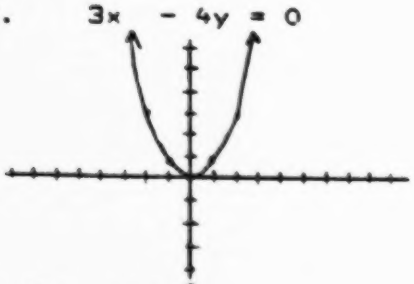
4. $\theta = 20°$



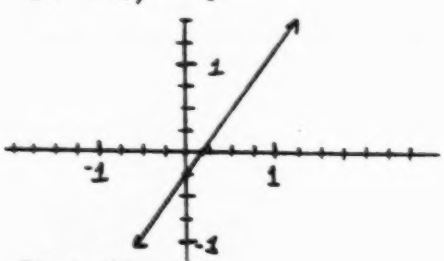
$\theta = 120°$



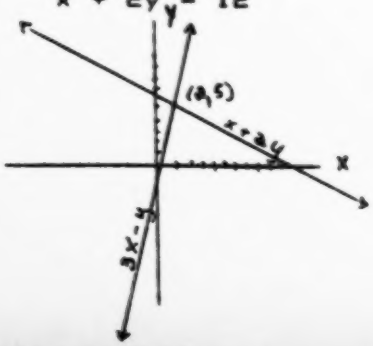
5. $3x - 4y = 0$



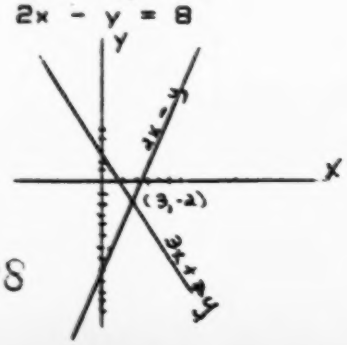
$6x - 4y = 1$



6. $3x - y = 1$
$x + 2y = 12$



$3x + 2y = 5$
$2x - y = 8$



7. $52 = 5.2 \times 10$ $\qquad 695 = 6.95 \times 10^{2}$

8. $(5 \times 10^{3}) + (7 \times 10^{3}) = 1.2 \times 10^{4}$
$(9.2 \times 10^{3}) - (8.7 \times 10^{3}) = 5 \times 10^{2}$

11. $(4a^{2}b)^{2} = 16a^{4}b^{2}$ $\qquad (3a^{2}b^{3})^{2} = 9a^{4}b^{4}$

13. $\sqrt{4a^{4}b^{2}} = 2ab$ $\qquad \sqrt{25a^{4}b^{2}} = 5a^{2}b$

15. $(a + b)^{2} = a^{2} + 2ab + b^{2}$ $\qquad (3x + 2)^{2} = 9x^{2} + 12x + 4$

17. $a^{5} \times a^{6} = a^{11}$ $\qquad b^{4}/b^{3} = b$

18. $(b^{3})^{4} = b^{12}$ $\qquad (c^{4})^{2} = c^{8}$

19. $(x^{a}/y^{b})^{c} = x^{ac}/y^{bc}$ $\qquad (x^{m}/y^{n})^{p} = x^{mp}/y^{np}$

20. $a^{-4}b^{-2} = \frac{1}{a^{4}b^{2}}$ $\qquad x^{-3}y^{-6} = \frac{1}{x^{3}y^{6}}$

21. $(25)^{1/2} = 5$ $\qquad (8)^{1/3} = 2$

25. $8 - (-3x) + 2y = 8 + 3x - 2y$
$4(p - 5) - 3(p - 2) = p - 14$

27. $x + 5 = 10$
$x = 10 - 5$
$x = 5$

$3i + 5 = 20$
$3i = 15$
$i = 15$

28. $x - z = 2 - z$
$x = 2$

$y + x = 14 + x$
$y = 14$

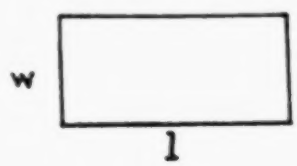
29. $4x + 3 = 15$
$x = 3$
Check:
$4(3) + 3 = 15$
$12 + 3 = 15$

$9y + 6 = 24$
$y = 2$
Check:
$9(2) + 6 = 24$
$18 + 6 = 24$

30. $E = 30$ v

$R = 5$
$I = \frac{E}{R}$
Use $I = \frac{E}{R}$

width = 4 length = 6
Find the perimeter
$P = (2l + 2w)$
$= 2(4 + 6) = 2(10) = 20$



31. R_1, R_2, R_3, R_4 are in a series.

$R = 10\Omega \quad R = 20\Omega \quad R = 30\Omega$
$R_1 + R_2 + R_3 + R_4 = 100\,\Omega$
$10 + 20 + 30 + R_4 = 100\,\Omega$
$R_4 = 40\,\Omega$
$E_1 = 50v \quad E_2 = 125v \quad E_3 = 75v$
$E_t = E_1 + E_2 + E_3$
$E_t = 250v$

32. Given: $E = 110v \quad I = 5a$
$P = ?$
$R = \frac{E}{I} = \frac{110}{5} = 22\,\Omega$
$P = I^2R = 5^2 \times 22 = 550w$

$I = 10a \quad E = 110v$
$P = ?$
$R = \frac{E}{I} = \frac{110v}{10a} = 11\,\Omega$
$P = I^2R = 10^2 \times 11 = 1100w$

33. $R_1 = 20\,\Omega \quad R_2 = 50\,\Omega \quad R_3 = 30\,\Omega \quad I = 2.5a$
$E_1 = IR_1 = 2.5 \times 20 = 50v$
$E_2 = IR_2 = 2.5 \times 50 = 125v$
$E_3 = IR_3 = 2.5 \times 30 = 75v$
$E_t = E_1 + E_2 + E_3 = 250v$
$R_c = 300\,\Omega \quad I = 250ma \quad E = 120v$
$E_c = IR_c = 250 \times 300 = 75v$
$E_x = E - E_c = 120 - 75 = 45v$
$R_x = \frac{E_x}{I} = \frac{45}{.250} = 180\,\Omega$

34. $y^2 - 36 = 0$
$y = \pm 6$

$x^2 = 625$
$x = \pm 25$

35. $6a^2 + 3a - 7 = 0$
$a = \frac{-3 \pm \sqrt{9 + 168}}{12}$
$a_1 = \frac{10.304}{12} = .858$
$a_2 = \frac{-16.304}{12} = -1.359$

$8b + 4a - 6 = 0$
$a = \frac{-4 \pm \sqrt{16 + 192}}{16}$
$a_1 = \frac{10.422}{16} = .651$
$a_2 = \frac{-18.422}{16} = -1.151$

37. $3x + 3yx = 1$
$3x(1 + y) = 1$

$27b^2a + 3cba = 0$
$3ba(9b + c) = 0$

38. $3ax^2 + 6ax + 3ay^2 = 0$
$3a(x^2 + x + y^2) = 0$

$5by^2 + 15cby + 25bx = 0$
$5b(y^2 + 3cy + 5x) = 0$

39. $(x + y)(x - y) = x - y$

$(2b + 2a)(2b - 2a) = 4b - 4a$

41. $x + 3 = 13$
$+(x - y = 1)$
$2x = 14$
$x = 7$

$6x + 2y = 12$
$-(4x - 2y = 3)$
$2x = 9$
$x = 9/2$

42. $c + 4b = 8$

$b + a = 6$

$2c - 6b = 7$
$c = 8 - 4b$
$2(8 - 4b) - 6b = 7$
$-14b = -9$
$b = 9/14$
$c = 8 - 4(9/14)$
$c = 38/7$

$a - b = 2$
$a = 2 + b$
$b = 2$
$b + (2 + b) = 6$
$2 + 2b = 6$
$b = 2$
$a = 2 + 2 = 4$

43. (1) $x - 4y = 14$
(2) $4x + y = 5$
(1) $x = 14 + 4y$
(2) $x = \frac{5 - y}{4}$
$14 + 4y = \frac{5 - y}{4}$
$56 + 16y = 5 - y$
$17y = -51$
$y = -3$
(1) $x + 12 = 14$
$x = 2$

(1) $2x + y = 14$
(2) $4x - 3y = 8$
(1) $2x = 14 - y$
$x = 7 - 1/2y$
(2) $4x = 8 + 3y$
$x = 2 + 3/4y$
$7 - 1/2y = 2 + 3/4y$
$28 - 2y = 8 + 3y$
$-2y = 8 + 3y - 28$
$2y = -8 - 3y + 28$
$5y = 20$
$y = 4$
(1) $x = 7 - 2$
$x = 5$

44. $\frac{x}{4} + \frac{y}{3} = \frac{7}{12}$
$\frac{x}{2} - \frac{y}{4} = \frac{1}{4}$
(1) $3x + 4y = 7$
(2) $2x - y = 1$
$11x = 11$
$x = 1$
(1) $3 + 4y = 7$
$4y = 4$
$y = 1$

$\frac{x}{2} - \frac{y}{10} = 3$
$\frac{x}{4} + \frac{y}{5} = 4$
(1) $5x - y = 30$
(2) $-(5x + 4y = 80)$
$-5y = -50$
$y = 10$
(1) $5x - 10 = 30$
$5x = 40$
$x = 8$

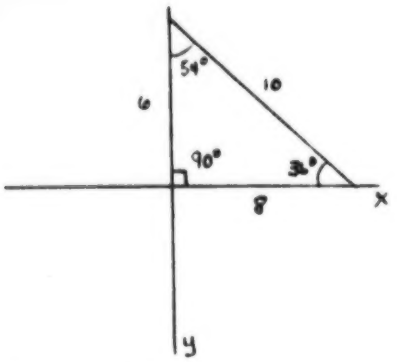
48. Second quadrant:
$\sin 140^\circ = \sin(180^\circ - 140^\circ) = \sin 40^\circ = .6428$
$\cos 100^\circ = -\cos(180^\circ - 100^\circ) = -\cos 80^\circ = -.1736$

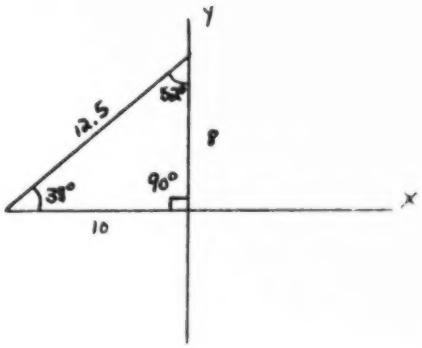
Third quadrant:
$\sin 200^\circ = -\sin(200^\circ - 180^\circ) = -\sin 20^\circ = -.3420$
$\cos 260^\circ = -\cos(260^\circ - 180^\circ) = -\cos 80^\circ = -.1736$

Fourth quadrant:
$\sin 300^\circ = -\sin(360^\circ - 300^\circ) = -\sin 60^\circ = -.8660$
$\cos 285^\circ = \cos(360^\circ - 285^\circ) = \cos 75^\circ = .2588$

50. $\sin 26.44^\circ = .4452$
$\cos 88.1^\circ = .0332$
$\sin 13.6^\circ = .2351$
$\tan 48.8^\circ = 1.1423$

52.





59. Ohm's Law :
Current is equal to the direct proportion of voltage to resistance.

$$I = \frac{E}{R}$$

Kirchhoff's Law :
The algebraic sum of the currents at any junction of conductors is zero.

$$R_1 I + R_2 I + R_3 I = 0$$

60. $5^2 = 25$ $\quad 2 = \log_5 25$
$5^4 = 625$ $\quad 4 = \log_5 625$

61. $\log_{10} (100 \times 10{,}000) = \log_{10} 100 + \log_{10} 10{,}000 = 6$
$\log_4 (64 \times 2) = \log_4 64 + \log_4 2 = 3.5$

62. $\log_{10} \frac{10}{1} = \log_{10} 10 - \log_{10} 1 = 1 - 0 = 1$

$\log_4 \frac{625}{64} = \log_4 625 - \log_4 64 = 5 - 3 = 2$

63. $\log_{10} 100^2 = 2 \log_{10} 100 = 4$
$\log_2 8^2 = 2 \log_2 8 = 6$

64. $\log_{10} \sqrt{10{,}000} = 1/2 \log_{10} 10{,}000 = 4/2 = 2$
$\log_{10} \sqrt[3]{100} = 1/3 \log_{10} 100 = 2/3$

65. $\log_{10} 140 = 2.1461$ $\quad \log_{10} 63 = 1.7993$

66. $\log_{10} 10{,}000 = 4$ $\quad 10^4 = 10{,}000$
$\log_2 16 = 4$ $\quad 2^4 = 16$

67. antilog 2.8401 = 692 $\quad$ antilog .9101 = 8.13

68. 3.6874 + 2.3265 = 6.0139 $\quad \bar{4}.3265 = 6.3265 - 10$

$+6.2843$

$2.6108 = 12.6108 - 10$

69. $4.1073 = 14.1073 - 10$

-6.9860

$7.1213 - 10$

$1.6725 = 11.6725 - 10$

$-5.7856 - 10$

5.8869

73. $\log \frac{642 \times 8.63}{37.2} = (\log 642 + \log 8.63) - \log 37.2$

$= (2.8075 + .9360) - 1.5705$

$= 2.173$

$\log \frac{3793 \times 70.2}{265} = (\log 3793 + \log 70.2) - \log 265$

$= (3.5790 + 1.8463) - 2.4232$

$= 3.0021$

78. $i = \frac{E}{R}(1 - \epsilon^{-\frac{Rt}{L}})$ $\quad i = \frac{12}{15}(1 - \epsilon^{-\frac{15 \times .06}{.75}})$

$i = 0.8(1 - \epsilon^{-1.2})$ $\quad i = 0.8 - 0.8\epsilon^{-1.2}$

$i = 0.8 - \frac{.8}{\epsilon^{1.2}}$ $\quad \log_{10} \epsilon^{1.2} = 1.2 \log_{10} \epsilon$

$\log_{10} \epsilon^{1.2} = 1.2 \log_{10} \epsilon = 1.2 \times .4343 = .5212$

$\epsilon^{1.2} = 3.32$ $\quad i = .8 - \frac{.8}{3.32}$

$i = .559a$

$i = \frac{E}{R}\epsilon^{-\frac{t}{RC}}$ $\quad i = \frac{.3E}{R} = \frac{.3 \times 110}{500} = .066a$

$.066 = \frac{110}{500}(\epsilon^{-\frac{t}{500 \times 20 \times 10^{-6}}})$

$.066 = .22\epsilon^{-\frac{t}{10^{-2}}} = .22\epsilon^{-100t}$

$.3 = \epsilon^{-100t} = \frac{1}{\epsilon^{100t}}$ $\quad .3\,\epsilon^{100t} = 1$

$\epsilon^{100t} = 3.33$ $\quad \log_{10} \epsilon^{100t} = \log_{10} 3.33$

$\log_{10} \epsilon^{100t} = \log_{10} 3.33$ $\quad 100t \log \epsilon = \log 3.33$

$100t \times .4343 = .5224$ $\quad 43.43t = .5224$

$t = .012$ sec

79. $db = 10 \log_{10} \frac{P_2}{P_1}$ $\quad P_1 = 10$ milliwatts

$P_2 = 120$ milliwatts

$db = 10 \log \frac{120}{10} = 10 \log 12 = 10.8$ db gain

$P_1 = 6$ $\quad db = -64$

$-64 = 10 \log \frac{P_2}{6}$ $\quad -6.4 = \log \frac{P_2}{6}$

$3.6 - 10 = \log \frac{P_2}{6}$ $\quad 3.98 \times 10^{-7} = \frac{P_2}{6}$

$P_2 = 2.39 \times 10^{-6}$ mw

80. How much power is represented by a gain of 23 db ?

$23 = 10 \log \frac{P_2}{6}$ $\qquad 2.3 = \log \frac{P_2}{6}$

antilog $2.3 = \frac{P_2}{6}$ $\qquad 199.5 = \frac{P_2}{6}$

$P_2 = 1197$ mw

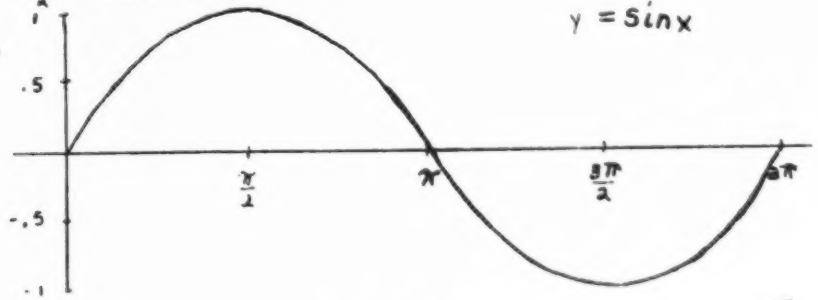
How much power is represented by -64 db ?

$-64 = 10 \log \frac{P_2}{6}$ $\qquad -6.4 = \log \frac{P_2}{6}$

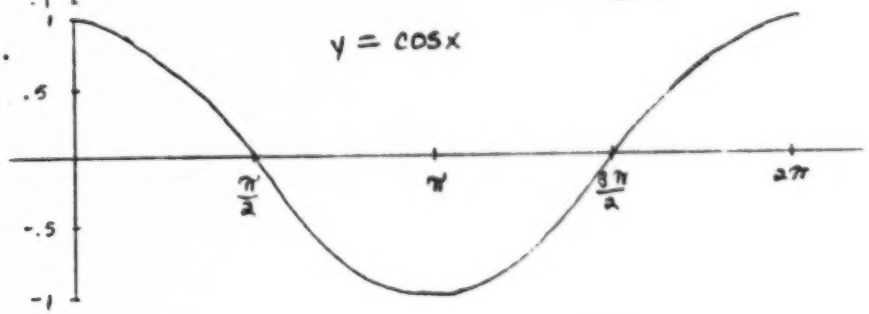
antilog $-6.4 = \frac{P_2}{6}$ $\qquad 3.98 \times 10^{-7} = \frac{P_2}{6}$

$P_2 = 2.39 \times 10^{-6}$ mw

84.



85.



86. $f = \frac{w}{2\pi}$ ~ $\qquad w = 377$

$f = \frac{377}{2\pi} = 60$ ~

$w = 455$ $\qquad f = \frac{455}{2\pi} = 72.4$~

87. $w = 2\pi f$ $\qquad f = 56$

$f = 30$ $\qquad w = 2\pi \times 56 = 351.86$ r/s

$w = 2\pi \times 30 = 188.4$ rad/sec

88. $y = 25 \sin (2\pi t + 30°)$; $\qquad r = 25$

$y = 32 \sin (37.7t - 10°)$; $\qquad r = 32$

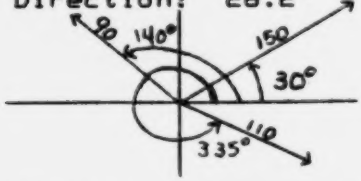
89. $e = 325 \sin (314t - 18°)$; $\qquad$ period = .02

$e = E_m \sin (157t + 17°)$; $\qquad$ period = .04

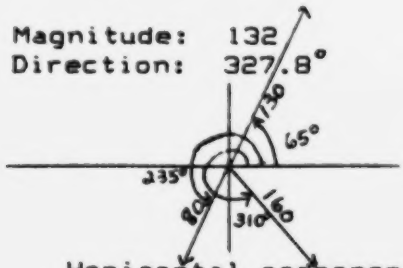
90. $i = I_m \sin (6.28 \times 10^3 - 90°)$; $\qquad 90°$ lag

$y = 32 \sin (120t - 30°)$; $30°$ lag

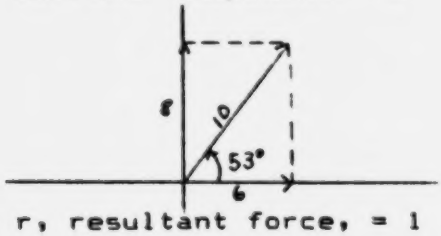
91. Magnitude: 182.5
Direction: 28.2°



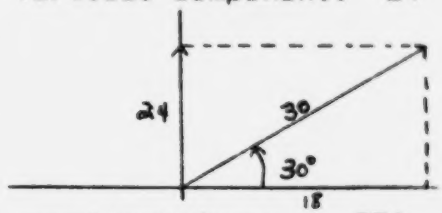
Magnitude: 132
Direction: 327.8°



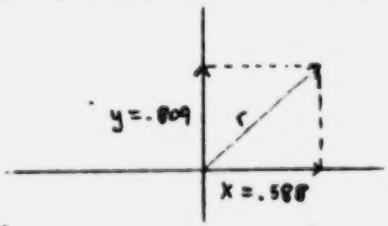
92. Horizontal component: 6
Vertical component: 8



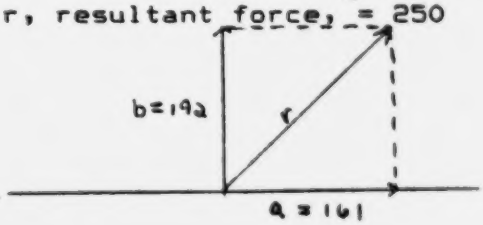
Horizontal component: 18
Vertical component: 24



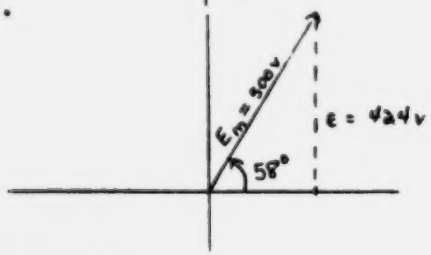
93. r, resultant force, = 1

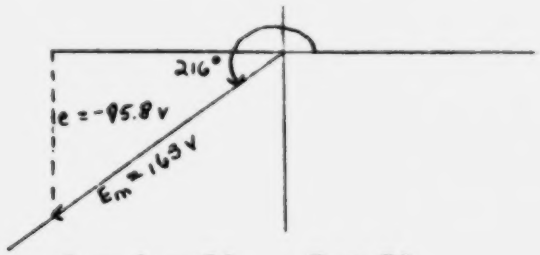


r, resultant force, = 250

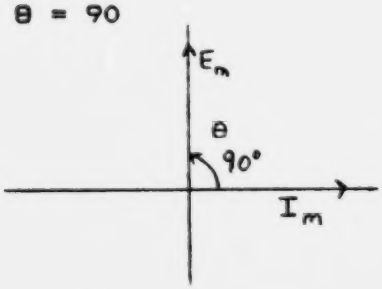


94.

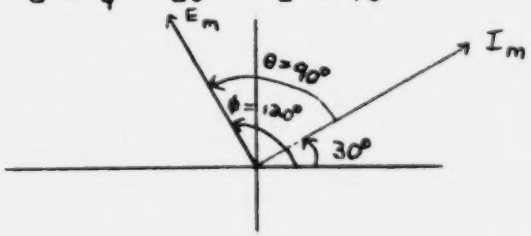




95. θ = 90



θ = ϕ − 30 θ = 90



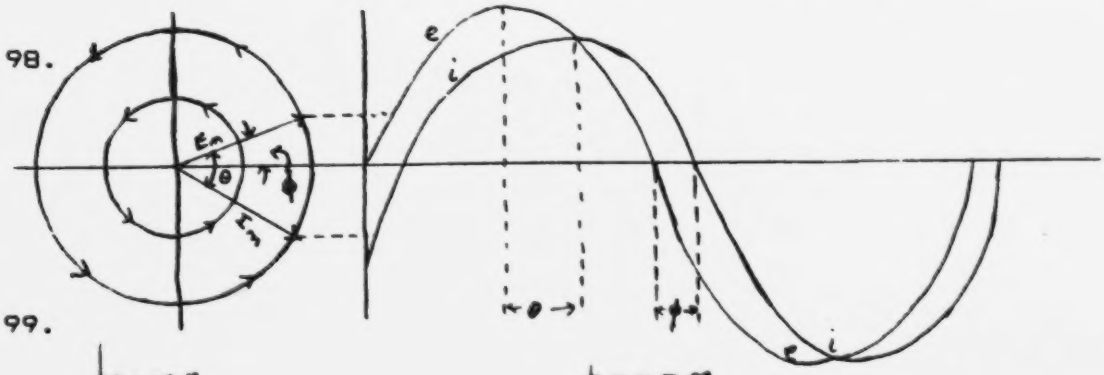
96. f = 30 $w = 2\pi \times 30 = 188.4$ rps

$f = \frac{300 \text{ rpm}}{60} = 5$ rps $w = 2\pi \times 5 = 10\pi$ or 31.4 rps

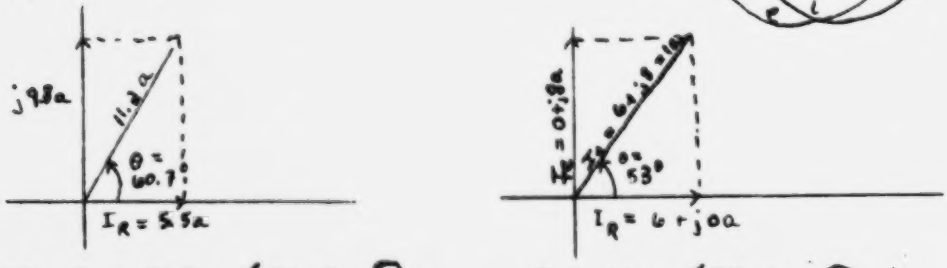
97. Maximum voltage : 170 volts
Maximum current : 14.1a
Frequency : 800
Phase angle : 40° lag
Voltage angle : 10
e = 170 sin 5030t v
i = 14.1 sin (5030t - 40°) a

Maximum voltage : 220 v
Maximum current : 14a
Phase angle : 60° lag
$E = \sqrt{2}\,E = \sqrt{2} \times 220 = 311$v
$\phi = 245° + 60° = 305° = -55°$
e = 311 sin (-55°) = -255 n

98.



99.



100. $Z = 269 \angle -21.8\ \Omega$ $Z = 10 \angle -53.1\ \Omega$

101. $Z = R - jx = 250 - j100$ ohms

$\tan\theta = \frac{x}{R} = \frac{100}{250} = .4$ $\theta = -21.8°$

$Z = \frac{x}{\sin\theta} = \frac{100}{\sin 21.8°} = 269\ \Omega$

or $Z = \frac{R}{\cos\theta} = \frac{250}{\cos 21.8°} = 269\ \Omega$

$Z = 269 \angle 21.8\ \Omega$

$\tan\theta = \frac{x}{R} = \frac{141}{75} = 1.88$ $\theta = 62°$

$Z = \frac{R}{\cos\theta} = \frac{75}{\cos 62°} = 160\ \Omega$ $Z = 160 \angle 62°\ \Omega$

102. Given : $I_R = \frac{E}{R} = \frac{120}{20} = 6a$ $I_L = \frac{E}{wl} = \frac{120}{15} = 8a$

$I_R = 6.0 + j0a$
$I_L = 0 + j8a$
$I_t = 6 - j8.0a$

Given : E = 120 $I_t = 10$ $\theta = 53.1°$

$Z_t = \frac{120}{10} = 12\ \Omega$ $Z = 12(\cos 53.1° + j\sin 53.1°)$
$= 7.2 + j9.6\ \Omega$

103. $I_a = 3.28 \angle -35^\circ a = 2.69 - j1.88a$
$I_b = 5.30 \angle 58^\circ a = 2.81 + j4.50a$
$I_c = 1.71 \angle 20^\circ a = 1.61 + j.585a$
$I_t = 7.11 + j3.205a$
$\theta_{de} = \frac{3.20}{7.11} = .450 = \angle 24.2^\circ$
$Z_{de} = \frac{E_{de}}{I_{de}} = \frac{100}{7.80} = 12.8 \angle -24.2^\circ \Omega$

104. $4.60 + j2.82$ $+2.11 - j8.10$ $6.71 - j8.10$

$6.4 - j\,8.5$ $+10.3 + j19.8$ $16.7 + j11.3$

105. $14.6 + j8.84$ $-\ 3.7 + j4.62$ $10.9 - j13.46$

$25.9 - j46.8$ $-14.7 - j10.4$ $11.2 - j36.4$

106. $8 + j5$ $10 + j9$ $80 + j50$ $+ j72 + j245$ $80 + j122 - 45$ $= 35 + j122$

$80 + j39$ $35 - j50$ $2800 + j1365$ $- j4000 - j21950$ $2800 - j2635 + 1950$ $= 4750 - j\,2635$

107. $\frac{50 + j35}{8 + j5} = 6.46 + j.337$ $\frac{10}{3 + j4} = 1.2 - j1.6$

108. $(8 + j5)(10 + j9) = 127 \angle 74^\circ$
$(80 + j39)(35 - j50) = 5430 \angle -29^\circ$

109. $\frac{50 + j35}{8 + j5} = 6.46 \angle 30^\circ$ $\frac{10}{3 + j4} = 2.0 \angle -53^\circ$

110.

Decimal	Binary
4	0100
15	1111

111.

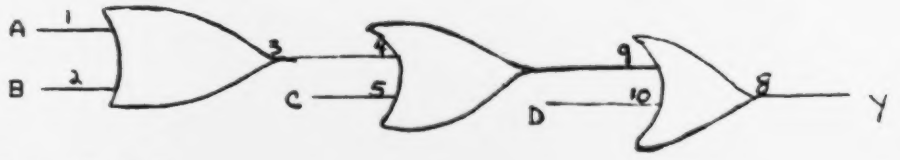
A	B	Y
0	0	0
0	1	1
1	0	1
1	1	1

0 = low voltage

1 = high voltage

A	B	Y
low	low	low
low	high	high
high	low	high
high	high	high

207

112. 

$Y_3 = A + B$
$Y_6 = Y_3 + C = A + B + C$
$Y_8 = Y_6 + D = A + B + C$

113. $Y = \bar{A}\bar{B}\bar{C} + \bar{A}B\bar{C} + A\bar{B}\bar{C} + AB\bar{C}$
$Y = (\bar{A}\bar{B} + \bar{A}B + A\bar{B} + AB)\bar{C}$
$Y = [\bar{A}(\bar{B} + B) + A(\bar{B} + B)]\bar{C}$
$Y = [\bar{A}(1) + A(1)]\bar{C} = (\bar{A} + A)\bar{C}$
$Y = \bar{C}$
$Y = A\bar{B}C + ABC$
$Y = (\bar{B} + B)AC$
$= AC$

114.

A	B	C	Y
0	0	0	0
0	0	1	0
0	1	0	0
0	1	1	1
1	0	0	0
1	0	1	1
1	1	0	1
1	1	1	1

$Y = \bar{A}BC + A\bar{B}C + AB\bar{C} + ABC$

115. $Y = A\bar{B} + AB$
$Y = A(\bar{B} + B)$
$Y = A(1) = A$

$Y = (\bar{A}+B)(A+B)$
$Y = \bar{A}A + \bar{A}B + BA + BB$
$Y = \bar{A}B + AB + B$
$Y = B$

116.

A	B	Y
0	0	0
0	1	0
1	0	1
1	1	1

	$\bar{B}$	B
$\bar{A}$	0	0
A	1	1

A	B	C	Y
0	0	0	0
0	0	1	0
0	1	0	1
0	1	1	0
1	0	0	0
1	0	1	0
1	1	0	1
1	1	1	1

	$\bar{C}$	C
$\bar{A}\bar{B}$	0	0
$\bar{A}B$	1	0
AB	1	1
$A\bar{B}$	0	0

117.

	$\bar{C}$	C
$\bar{A}\bar{B}$	0	0
$\bar{A}B$	1	0
AB	1	1
$A\bar{B}$	0	0

Three variable

	$\bar{C}\bar{D}$	$\bar{C}D$	CD	$C\bar{D}$
$\bar{A}\bar{B}$	0	1	0	0
$\bar{A}B$	0	0	1	1
AB	0	0	0	1
$A\bar{B}$	0	0	0	0

Four variable

118.

	$\bar{C}\bar{D}$	$\bar{C}D$	CD	$C\bar{D}$
$\bar{A}\bar{B}$	0	0	0	0
$\bar{A}B$	0	0	0	0
AB	1	1	1	1
$A\bar{B}$	1	1	1	1

Octet

	$\bar{C}\bar{D}$	$\bar{C}D$	CD	$C\bar{D}$
$\bar{A}\bar{B}$	0	1	1	1
$\bar{A}B$	0	0	0	1
AB	1	1	0	1
$A\bar{B}$	1	1	0	1

Octets, quads, and pairs

119. $Y = (A + B + C)(A + B + \bar{C})(A + \bar{B} + C)$

A	B	C	Y
0	0	0	0
0	0	1	0
0	1	0	0
0	1	1	1
1	0	0	1
1	0	1	1
1	1	0	1
1	1	1	1

$Y = (A + \bar{B} + \bar{C})(A + \bar{B} + \bar{C})(\bar{A} + \bar{B} + C)$

A	B	C	Y
0	0	0	0
0	0	1	1
0	1	0	1
0	1	1	0
1	0	0	1
1	0	1	1
1	1	0	0
1	1	1	1

120. $Y = (A + B + C)(A + \bar{B} + \bar{C})(\bar{A} + \bar{B} + C)$

A	B	C	Y	
0	0	0	0	$\longrightarrow A + B + C$
0	0	1	1	
0	1	0	1	
0	1	1	0	$\longrightarrow A + \bar{B} + \bar{C}$
1	0	0	1	
1	0	1	1	
1	1	0	0	$\longrightarrow \bar{A} + \bar{B} + C$
1	1	1	1	

A	B	C	Y	
0	0	0	0	
0	0	1	0	
0	1	0	0	
0	1	1	1	$\longrightarrow \bar{A}BC$
1	0	0	0	
1	0	1	1	$\longrightarrow A\bar{B}C$
1	1	0	1	$\longrightarrow AB\bar{C}$
1	1	1	1	$\longrightarrow ABC$

121. $Y = (\bar{A} + B)(A + B)$
$Y = \bar{A}A + \bar{A}B + BA + BB$
$Y = \bar{A}B + AB + B$
$Y = (\bar{A} + A)B + B = B + B = B$

$Y = (A + B)(\bar{A} + \bar{B})$
$Y = A\bar{A} + AB + B\bar{A} + BB$
$Y = AB + B\bar{A} + B$
$Y = (A + \bar{A})B + B = B + B = B$

122.

A	B	C	D	Y
0	0	0	0	1
0	0	0	1	0
0	0	1	0	1
0	0	1	1	1
0	1	0	0	1
0	1	0	1	1
0	1	1	0	0
0	1	1	1	0
1	0	0	0	1
1	0	0	1	1
1	0	1	0	1
1	0	1	1	1
1	1	0	0	1
1	1	0	1	1
1	1	1	0	0
1	1	1	1	1

123. 429

4	2	9
↓	↓	↓
0100	0010	1001

8963

8	9	6	3
↓	↓	↓	↓
1000	1001	0110	0011

124. 1 0 1
4 ~~2~~ 1
4 + 1 = 5

1 0 1 0 1
16 ~~8~~ 4 ~~2~~ 1
16 + 4 + 1 = 21

125. Octal 23
$2(8^1) + 3(8^0) = 16 + 3 = 19$
Octal 257
$2(8^2) + 5(8^1) + 7(8^0) = 128 + 40 + 7 = 175$

126. decimal 23
0.23 x 8 = 1.84 = .84 with carry of 1
0.84 x 8 = 6.72 = 0.72 with carry of 6
0.72 x 8 = 5.76 = 0.76 with carry of 5
octal fraction 0.165

decimal 175

$$8\overline{)175}\ \ 7$$
$$8\overline{)21}\ \ 5$$
$$8\overline{)2}\ \ 2$$
$$0$$

257

127.

9	A	F	C	5	E	2
↓	↓	↓	↓	↓	↓	↓
1001	1010	1111	1100	0101	1110	0010

128. 12

1	2	4	5
+3	+3	↓	↓
4	5	0100	0101

29

2	9	5	12
+3	+3	↓	↓
5	12	0101	1100

129. 0011 0110

3	6
-3	-3
0	3

3 decimal

1001	01111
↓	↓
9	7
-3	-3
6	4

64 decimal

130.

Gray number	Decimal
1110	11
1000	15

131.

0101	0111
+0011	0101
1000	1100

0 F A C H
+3 8 7 F H
4 8 2 B H

132.

11100
+11010
110110

0000	1111	1010	1100
+0011	1000	0111	1111
0100	1000	0010	1011

133. Whole numbers, base 10

4,012
+14,463
18,475

16 bit numbers

0000	1111	1010	1100
+0011	1000	0111	1111
0100	1000	0010	1011

134.

1100	1000
-0111	1101
0100	1011

1001	0110
-0101	0101
0100	0001

135. $9_{10} - 1_{10} = 8_{10}$ $175_{10} - 50_{10} = 125_{10}$

136. $175_{10} + 118_{10} = 293_{10}$

overflow ↳1	1010	1111
	+0111	0110
	0010	0101

overflow ↳1	0111	1101
	+1011	1100
	0011	1001

137. -127 = 1111 1111 32,767 = 0111 1111 1111 1111

138. 1001 = -001 = -1 1010 = -010 = -2

139. 23H
1's complement :
DCH

FDH
1's complement :
02H

140. 0000 1111
2's complement :
0001 0100

1000 0001
2's complement :
0111 111

141. +78
2's complement :
0100 1110

-90
2's complement :
1010 0110

142.
```
  45          0010   1101
+56         +0011   1000
 101         0110   0101

  89          0101   1001
+-34        +1101   1110
  55          0011   0111
```

Table

EXAMPLES FOR MACHINE SHOP MATH COMPETENCIES

---

50. $\sin 26.44^\circ = .4452$ $\quad \sin 13.6^\circ = .2351$
$\cos 88.1^\circ = .0332$ $\quad \tan 48.8^\circ = 1.1423$

78. 20.48 miles = (20.48 x 1.069 km) = 21.893 km

79. Hole size : 1.498 to 1.502 inches
Tolerance : .004 inch

Open-end wrench (opening size) : .562 - .567 inches
Tolerance : .005 inch

80. Circumference = π x D
Radius = 2.1 ft.
Circumference = 13.19 ft.
Diameter = 1/2 inch
Circumference = 1.5708 inches

81. Perimeter of any Polygon = Sum of its Sides
S = 4 inches; Perimeter of a square = 4 + 4 + 4 + 4
= 16 inches
S = 2.378 mm
Perimeter of a hexagon = 2.378 + 2.378 + 2.378 + 2.378
+ 2.378 + 2.378 = 14.268 mm

82. Area of a circle = $\pi \times r^2$
r = 3 inches Area = π x 9 in. = 28.274 in
r = 15.4715 feet Area = π x 239.36731 ft. = 752 ft.

83. Pitch of a thread = $\frac{1}{\text{number of threads per inch}}$
N = 8.5 $\quad P = \frac{1}{8.5} = .1176$
N = 14 $\quad P = \frac{1}{14} = .07142$

84. Cutting speed = π x D x rpm
Rpm = 400
Diameter = 2"
CS = π x 2 x 400 = 2513.274 in/min = 209.44 ft/min
Rpm = 170
Diameter = 1 1/8"
Cs = π x 9/8 x 170 = 600.83 in/min = 50.069 ft/min

85. In a working year of 2400 hrs Maddie was absent from work for 72 hours. What percent of time was she absent?

$$\frac{72}{2400} \times 100\% = 3\%$$

946 pounds of brass has 138 pounds of zinc. What percentage of the brass is zinc ?

$$\frac{138}{946} \times 100\% = 14.59\%$$

86. 7 graduations exposed thimble reading is 8
Reading : .183 in.
Six full turns starting from zero; reading .150 in

87. Zero is at 2" and 6 graduations and the vernier coincides with the tenth line.
Reading : 2.160 in
Zero is at 1" and 3 graduations and the vernier coincides with the eigth line.
Reading : 1.083 in

88. 30 spaces on the vernier
The vernier zero is between $35^\circ 30'$ and 36°
The coinciding line is at 14
Total reading : $35^\circ 44'$

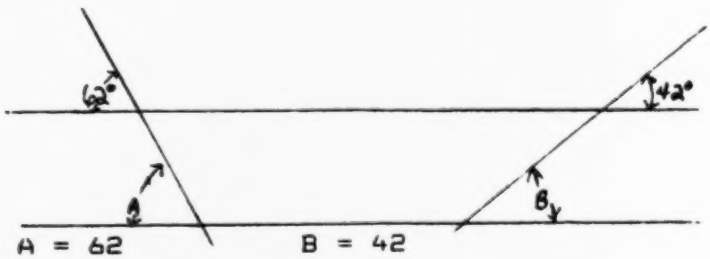
Vernier zero between 15° and $15^\circ 30'$
Coinciding vernier line at 12
Total reading : $15^\circ 12'$

89. $90^\circ - 21\ 53' = 68^\circ 07'$
$69^\circ 18' - 68^\circ 19' 31'' = 58' 29''$

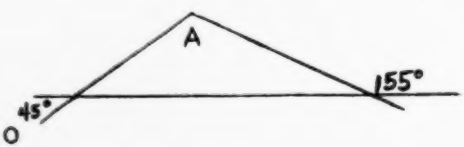
90. $\frac{30'}{60} = .5^\circ$ $\frac{19'}{60} = .317^\circ$

91. $6.53^\circ = 6^\circ + (.53 \times 60) = 6^\circ + 31.8' = 6\ 32'$
$11.7251^\circ = 11^\circ + (.7251 \times 60) = 11^\circ + 43.506'$
$= 11^\circ + 43' + (.506 \times 60) = 11^\circ 43' 30''$

92.



A = 62 B = 42



A = 110

93. Area of a triangle
Sides are : 5 cm, 8cm, and 11cm
Area = 18.33 sq. in.
Area of a parallelogram
Base : 2'9"
Altitude : 5'4"
Area = 14.67 sq. ft.
Area of a rectangle
Diagonal : 125'
Altitude : 75'
Area = 7500 sq. ft.
Area of a square
Diagonal : 12"
Area = 72 sq. in.

94. Distance across the flats of a square nut : 2 7/8
Diagonal = 4 1/16 in
Side of a square = 8.485 in
Diagonal = 12 inches

95. F = Distance Across Flats = $\frac{c}{1.155}$ c = Distance Across Corners

96. tan 36° 50' = .74900 cos 77° 20' = .21928

97. sin 15° 23' = ?

$$10\begin{cases}3\begin{cases}\sin 15^\circ 20' = .26443\\ \sin 15^\circ 23' = ?\end{cases}\\ \sin 15^\circ 30' = .26724\end{cases}$$

.00281

$\frac{3}{10} \times .00281 = .00084$

.26443
-.00084
sin 15° 23' = .26527

cos 82° 51' = ?

$$10\begin{cases}1\begin{cases}\cos 82^\circ 50' = .12476\\ \cos 82^\circ 51' = ?\end{cases}\\ \cos 83^\circ = .12187\end{cases}$$

.00289

$\frac{1}{10} \times .00289 = .0029$

.12476
-.00029
cos 82° 51' = .12447

98. $\frac{c}{\sin C} = \frac{d}{\sin D}$ $\frac{b}{\sin B} = \frac{C}{\sin C}$ $\frac{b}{\sin B} = \frac{d}{\sin D}$

$B = 25°$ $D = 80°$ $b = 15$ inches

Find C, c and d

$\frac{15}{\sin 25°} = \frac{d}{\sin 80°}$ $d = 34.954$ inches

$C = 75°$

$c = \frac{b \sin C}{\sin B}$ $C = 34.284$ inches

99. $b = 10$ ft $d = 12$ ft $C = 36°$

Find c

$c^2 = b^2 + d^2 - 2bd \cos C = 100 + 144 - 194.165 = 49.835$

$c = \sqrt{49.835} = 7.059$ ft

Find B

$\sin B = \frac{10\ (.58779)}{7.059} = .83268$ $B = 56° 23'$

100. Find the taper per inch

$D = 4.576$ $d = 4.013$ $L = 10$ inches

$TPI = (D - d)/L$

$= (4.576 - 4.013)/10 = .0563$ in per in

$D = .200$ inch $d = .162$ inch $L = 1\ \frac{13}{16}$

$TPI = \frac{(.200 - .162)}{1.8125} = .02096$ in per in

101. $\text{Offset} = \frac{\text{TPI} \times \text{Total Work Length Between Centers}}{2}$

TPI = .0357 in

Length between centers = 14

$\text{Offset} = \frac{.0357 \times 14}{2} = .250$ in

TPI = .0778

Length between centers = 15

$\text{Offset} = \frac{.0778 \times 15}{2} = .5835$ in

102. Length = 6 inches $D = 4.665$ inches $d = 3.105$ inches

$\frac{2 \times \tan \text{taper}}{24}$ = corresponding angle

$\frac{2 \times \tan .26}{24} = 14° 48'$

Length = 12 in $D = 2.005$ in $d = 1.03$ in

$\text{Taper} = \frac{2.005 - 1.03}{12} = .08125$

Corresponding angle = $4° 40'$

103. TPI = .026 in; in 3 inches, TPI should be .078 in

$D = 1.562$ $d = 1.500$ $D - d = .062$ in

$\text{Error per inch} = \frac{.078 - .062}{3} = .0053$ in

TPI = .0208 in; in 4 inches, TPI should be .0804 in
D = 1.251 in d = 1.232 in D - d = .019 in
Error per inch = $\frac{.0804 - .019}{4}$ = .01535 in

104. T = Number of Teeth on Driver S = Speed of the Driver
t = Number of Teeth on the Driven Gear
s = Speed of Driven Gear
T x S = t x s
t = 20 s = 150 rpm T = 30
$S = \frac{t \times s}{T} = \frac{(20)150}{30}$ = 100 rpm
T = 20 s = 200 rpm t = 40
$s = \frac{T \times S}{t} = \frac{20 \times 200}{40}$ = 100 rpm

105. T = 64 S = 700 rpm s = 400 rpm
$t = \frac{T \times S}{s} = \frac{64 \times 700}{400} = 112$

Rpm of Final Driven Gear =
Product of all Driving Teeth x Rpm of First Driving Gear
Product of all Driven Teeth
Rpm of A = 300 A = 24 T B = 64 T C = 36 T
D = 20 T
$Rpm = \frac{300 \times 24 \times 64}{20 \times 36} = 640$

106. Rpm of Gear x Thread Number = Speed of Worm x Number of Teeth on Worm Gear
Rpm of gear = 120 rpm
Thread number = 1
Number of teeth on worm gear = 60
Speed of worm gear = $\frac{120 \text{ rpm} \times 1}{60}$ = 2 rpm

Number of teeth = 40
Speed of gear = 80 rpm
Thread number = 1
Rpm of gear = $\frac{80 \times 1}{40} = 2$

107. $Rpm = \frac{4CS}{D}$ D = 3 CS = 300
$Rpm = \frac{4(300)}{3} = 400$
D = 5 CS = 375
$Rpm = \frac{4(375)}{5} = 300$

108. $\text{Rpm} = 4CS = \frac{4(125)}{2} = 250$

$250 \times .75 = 188$ rpm

$\text{Rpm} = \frac{4(125)}{.5} = 1000$rpm

$1000 \times .75 = 750$ rpm

109. Rate of Feed = Chip Load per Tooth x Number of Teeth x rpm

Chip load = .007
Number of teeth = 30
Rpm = 83
Rate = $.007 \times 30 \times 83 = 17.43$ per minute

Chip load = .002
Number of teeth = 12
Rpm = 86
Rate = $.002 \times 12 \times 86 = 2.064$

110. $\text{Cutting Time} = \frac{\text{Length of Cut}}{\text{Feed Rate per Minute}}$

Length of cut = 5.5
Feed rate = 2.2/min
Cutting time = $\frac{5.5}{2.2} = 2.5$ minutes

Length of cut = 2
Feed rate = .75/min
Cutting time = $\frac{2}{.75} = 2.67$ minutes

111. $\text{Pitch} = \frac{1}{N}$ $\quad N = 32 \quad P = \frac{1}{32} = .0312$

$N = 13 \quad P = \frac{1}{13} = .0769$

112. $M = D - 1.515\,P + 3G$

$G = .57735\,P \quad P = .0556 \quad D = .3125$

$M = .3125 - 1.515(.0556) + 3(.03208) = .3244$ inch

h = single depth of a thread = $.6495P$

$P = .0312$

$h = .6495(.0312) = .0203$

113. $N \times .013 + .060 =$ Outside Diameter of Machine Screws

$N = 10$

$10 \times .013 + .060 = .130 + .06 = .19$ inch

Tap Drill Size = TDS = OD - P

OD = 3/8 $\quad P = .0625$

TDS = $.375 - .0625 = .3125$

114. $\text{Outside Diameter} = OD = \frac{N + 2}{DP}$

DP = 18 $\quad N = 44$

$OD = \frac{44 + 2}{18} = \frac{46}{18} = 2.55$

DP = 24 $\quad N = 36$

$OD = \frac{36 + 2}{24} = \frac{38}{24} = 1.58$

115. $C = \frac{N + N}{2DP}$

$DP = 6 \quad N = 18 \quad N = 48$

$C = \frac{18 + 48}{2 \times 6} = \frac{66}{12} = 5.5$

$DP = 16 \quad N = 36 \quad N = 54$

$C = \frac{36 + 54}{2 \times 16} = \frac{90}{32} = 2.813$

118. $\text{Diametral pitch} = \frac{25.4}{\text{Module}}$

Module = 10

$\text{Diametral pitch} = \frac{25.4}{10} = 2.54$

Module = 7

$\text{Diametral pitch} = \frac{25.4}{7} = 3.63$

119. $T = \text{number of complete turns} = \frac{40}{D}$

D = number of divisions desired

$D = 8$

$T = \frac{40}{8} = 5$

$D = 20$

$T = \frac{40}{20} = 2$

120. $7^\circ 31' 49''$ 41 spaces on the 49-hole circle

$5^\circ 1' 45''$ 19 spaces on the 34-hole circle

Appendix 5

Evaluation Forms

EVALUATION FOR EXIT MATH COMPETENCIES OF SELECTED VOCATIONAL PROGRAMS

EVALUATION FOR EXIT MATH COMPETENCIES OF
SELECTED VOCATIONAL PROGRAMS

Directions: Please answer the information below and the evaluation information that follows.

Name: _____

School: _____

Address: _____

_____

_____

Telephone # _____

Position: _____

I will evaluate the following: (Check one or more)

____ Drafting

____ Electricity

____ Electronics

____ Machine Shop

Please return the completed evaluation to:

Dr. Richard Crosby
Dept of Occupational Education
University of Louisville
Louisville, Ky 40292

Directions: Please answer the following questions as directed. Evaluate the handbook for the information that relates to the training program(s) you selected.

Evaluation of Section 1:

1. The narrative in Section 1 was clear, helpful, to the point. Yes __ No __

Suggestions _____

_____

2. The narrative in Section 2 was clear, helpful, to the point. Yes __ No __

Suggestions _____

_____

3. The narrative in Section 3 was clear, helpful, to the point. Yes __ No __

Suggestions _____

_____

4. The narrative in Section 4 was clear, helpful, to the point. Yes __ No__

Suggestions _____

_____

5. The material in the Appendices was clear, helpful, to the point. Yes __ No__

Suggestions _____

_____

Other Suggestions or Comments: _____

_____

_____

_____

6. In my opinion, the following competencies should be eliminated from Table ___ (put in the number of table you were evaluating). List below why you think the competency is not needed.

Table #	Competency Number	Competency	Reason Not Needed

7. In my opinion, the following competencies should be added to Table ___.
(Put in the number of the table you were evaluating).

Competencies

8. I think the following resources should be added for the Drafting, Electricity, Electronics, Machine Shop training program. (Please circle the training program name for which the resources should be used).

Other comments about the handbook:

EVALUATION FOR EXIT MATH COMPETENCIES OF
SELECTED VOCATIONAL PROGRAMS

Directions: Please answer the information below and the evaluation information that follows. The first part of the evaluation form deals with the competencies that were selected by the instructors in your area. The second part of the evaluation deals with the additional exit math competencies suggested by the instructors in your area. At the end of the evaluation form, you will be given a chance to write in any comments or competencies which you feel are necessary for graduation from a post-secondary program in your area.

Name: _____

School: _____

Address: _____

_____

_____

Telephone #: _____

Position: _____

I have evaluated the following: (Check one)

____ Auto Body

____ Auto Mechanics

____ Carpentry

____ Graphic Arts

____ Air Conditioning

____ Welding

____ Masonry

Please return the completed evaluation to:

Dr. Richard Crosby
Department of Occupational Education
University of Louisville
Louisville, Kentucky 40292

Directions: Please answer the following questions. Evaluate the information that relates to the training program you checked on the first page.

Evaluation of Section 1: Selected Math Competencies

1. All of the competencies accurately reflect the math needed to graduate from your program. Yes __ No __

2. If the answer to #1 was NO, list the number(s) of the competencies that are not needed to graduate from your program.

3. Comments:

_____
_____
_____
_____
_____
_____
_____
_____
_____
_____

Evaluation of part II: Additional Competencies List

1. These additional competencies are needed for completion of my program. Yes __ No __

2. Comments:

_____
_____
_____
_____
_____
_____
_____
_____
_____